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The New South Brooklyn Freight Terminal, New York Harbor

By Charles W. Staniford* and Philip Guise†

The enormous commerce of the port of New York, constantly growing with phenomenal rapidity, has made the existing dockage and wharfage facilities of the harbor inadequate. Immediate relief is necessary in parts of the harbor. It is imperative that the city of New York decide without delay upon a definite policy of harbor improvement broad enough to keep the dock and wharfage facilities abreast of the growth of commerce without crippling the financial resources of the city, and that it proceed without delay upon the progressive development of the harbor on these lines.

It is the purpose of this paper to show to what extent some of the requirements of the harbor have been provided for, with the limited funds appropriated, in developing a freight steamship terminal at South Brooklyn; to describe the construction work there undertaken by the city, through its Department of Docks & Ferries, and to illustrate the types and kinds of structures there built and the improvements made.

Fig. 1. The Gowanus Section of the South Brooklyn Improvement Before Work Was Begun. (Oct. 1, 1908)

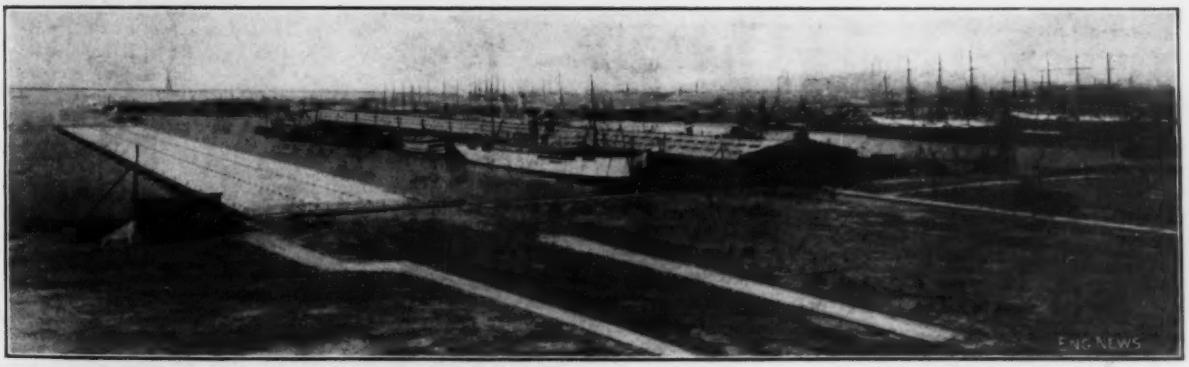


Fig. 2. The Gowanus Section as Improved

(A steel pier-shed was later built on the 33rd St. Pier.)

The Commerce of New York Harbor

It will be of interest and perhaps necessary for a proper comprehension of the subject matter to briefly review the development of the harbor and to consider what its requirements are.

The harbor of New York is unquestionably one of the finest natural harbors of the continent, perhaps of the world. Until the beginning of the 19th century it was predicted that Boston (or even Newport) would become the great port of North America. As late as 1812, Philadelphia was the superior of New

*Chief Engineer, Department of Docks and Ferries, New York City; Pier A, North River, New York.

†Assistant Engineer, Dept. Docks and Ferries, Gowanus Section, foot of 32d St., Brooklyn.

York as a financial and commercial center. Contrary to all predictions, however, New York has left all other cities far behind in its phenomenal growth, and today its commerce exceeds that of any other port in the world, including its great rivals London and Hamburg. Its population, according to the last census, is also increasing about 2½ times as fast as that of London.

The measure of the commerce of a port is the total volume of tonnage of vessels entering and clearing. The total tonnage entered and cleared at London during 1910 (was, in round numbers) 20,230,000 tons; at Hamburg, 22,300,000 tons; at New York City, 25,600,000 tons. The corresponding figures for New York City for the year 1901 were approximately 16,800,000 tons. Therefore the average increase in tonnage during the past ten years has been a million tons per annum.

The value of imports through New York Harbor during the year 1910 approximated $936,000,000, the exports $652,000,000, a total of $1,588,000,000, netting the federal government a revenue of approximately $200,000,000.

That the present growth of commerce of the port will receive further great impetus by the completion of the Panama Canal is clearly evident. The opening of this new path to the Pacific Coast will place New York manufacturers and commercial houses in the position of quoting practically New York prices for their goods to San Francisco consumers. The term "New York manufacturers" is here meant to include all manufacturers or producers within the area tapped by the New York Barge Canal, now approaching completion, as well as those of New England and adjacent states engaged in the Western and Oriental trade; the latter trade will then no longer require shipment by rail from and to the Pacific Coast, but will come to New York direct, independent of railroad rates.

It will be generally conceded that the commercial and industrial prominence of New York City, in fact its existence, is due to the natural advantages of its harbor: its accessibility from the sea, its safety to vessels, and last but not least its advantageous location with respect to the land, i.e., the adjacent country.

The harbor, then, is the great revenue-producing plant which has developed the industries and manufactories of the city, and consequently attracted the population required by these industries. New York may, therefore, be said to be literally in the harbor business. In no wise does the city materially differ from other business concerns as far as the up-keep of its producing plant, in this case the harbor, is concerned.

Condition and Needs of the Harbor

About twelve years ago, the Department of Docks & Ferries of the city faced the problem of extending the docking and wharfage facilities along the North River shore of Manhattan Island to accommodate the growing shipping. A study of the conditions as they existed at that time resulted in the "Chelsea Improvement," the first example of systematic development of a considerable portion of the water-front upon a comprehensive plan devised to meet a general requirement, namely, that of providing for the transatlantic passenger lines entering the harbor. The Chelsea piers were completed in 1909. Two years later the War Department, after repeated public hearings and the strongest arguments by shipping men and others interested, reluctantly granted permission to extend these piers temporarily 100 ft. beyond the established pierhead line. This action was necessary in order that a pier of sufficient length could be in readiness on the North River, in Manhattan, for the arrival of the new steamer "Olympic," of the White Star Line, 882½ ft. in length, 99½ ft. beam, 66,000 tons displacement.

It will be noted that the permit granted by the War Department is temporary only. Permanent provision must be made for these great liners at once. No other pier sites along the North River are today available for vessels of the "Olympic" class, not to speak of provision for the super-"Olympic," let us say, the 1000-ft. class which is coming. The "Gigantic," now projected by the White Star Line, is to be 1000 ft. long, 111 ft. beam and 70,000 tons displacement. The Hamburg-American Line, it is reported, has placed an order with Harland & Wolff, of Belfast, for a vessel of 80,000 hp., twice the power of the "Olympic."

The great increase in length of the modern transatlantic liners over the steamship of ten years ago was not foreseen by shipping men at that time. Their growth is abnormal and due primarily to the recent rivalry between the great passenger lines, each striving to possess the largest and most palatial vessel. Since these giants have arrived, however, they must be provided for by the re-arrangement or expansion of dockage facilities to insure their accommodation, since their removal to other ports must be considered in the light of a great economic loss to the community at large.

Public opinion is a dominant factor in the determination of the policy or method of procedure to initiate public improvements. Public interest and opinion have been apathetic as far as New York harbor developments are concerned, and in fact the public was generally ignorant of the conditions obtaining in the harbor until the recent agitation for extension of the Chelsea piers drew general attention to the congested condition of the water front.

A few months ago the question of docking the new great ocean liners of the "Olympic" type resulted in serious consideration of the removal of at least one of the great transatlantic lines to Montauk Point, where, it was considered, a new harbor could be established, and where, once the migration begun, other lines would rapidly follow. Such a removal or exodus is not only by no means impossible, but the question of dockage for the super-"Olympic" class has again brought its serious contemplation before the steamship companies, and unless provision is made for these vessels they will be forced to seek other harbors on the Atlantic Coast. Boston, Portland and Montreal are striving to obtain a part of the commerce of New York harbor. The Commonwealth of Boston has within the past few weeks appropriated $9,000,000 for improvement of its harbor. The effect of such removal upon many kinds of business in New York City can be readily imagined.

Successful industrial concerns, while observing a proper balance in all departments of their business establishments, spending a judicious portion of their income on each in proportion to its importance relative to the whole, strain every nerve, so to speak, to keep at the top notch of efficiency their revenue-producing plant, that which produces the money to carry on the business, and in fact is the core of the business. New York City should not greatly differ from other business concerns in this respect. It must face the vital problem of proceeding without delay with the general improvement of its harbor upon a systematic plan of development, not only meeting the immediate pressing need of longer docks for the enormous transatlantic liners, but so broad in its scope as to keep at least abreast of the constantly growing commerce. This can be done by gradual expansion on broad lines, without crippling the resources of the city.

It is now contemplated to build subways in the city at a cost of some $145,000,000; this in order that rapid-transit for passengers, an incident of the city's "harbor business," be facilitated. An expenditure of one-half this sum, or say $70,000,000, upon improvement of the harbor would place the port of New York well on the way to the top notch of efficiency, its increased capacity soon directly and indirectly providing means to extend the passenger railroads beyond the remaining $75,000,000 if found necessary.

Examples of this far-seeing policy of improvement and development to meet the growth of trade are at hand on every side, notably in the immense works under way or recently completed by the railroads entering the city, the Pennsylvania R.R. tunnels, the New York Central Terminal, etc. It is yet to be shown where a great railroad corporation has deliberately expended vast sums without seeing a fair interest on its investment. It has

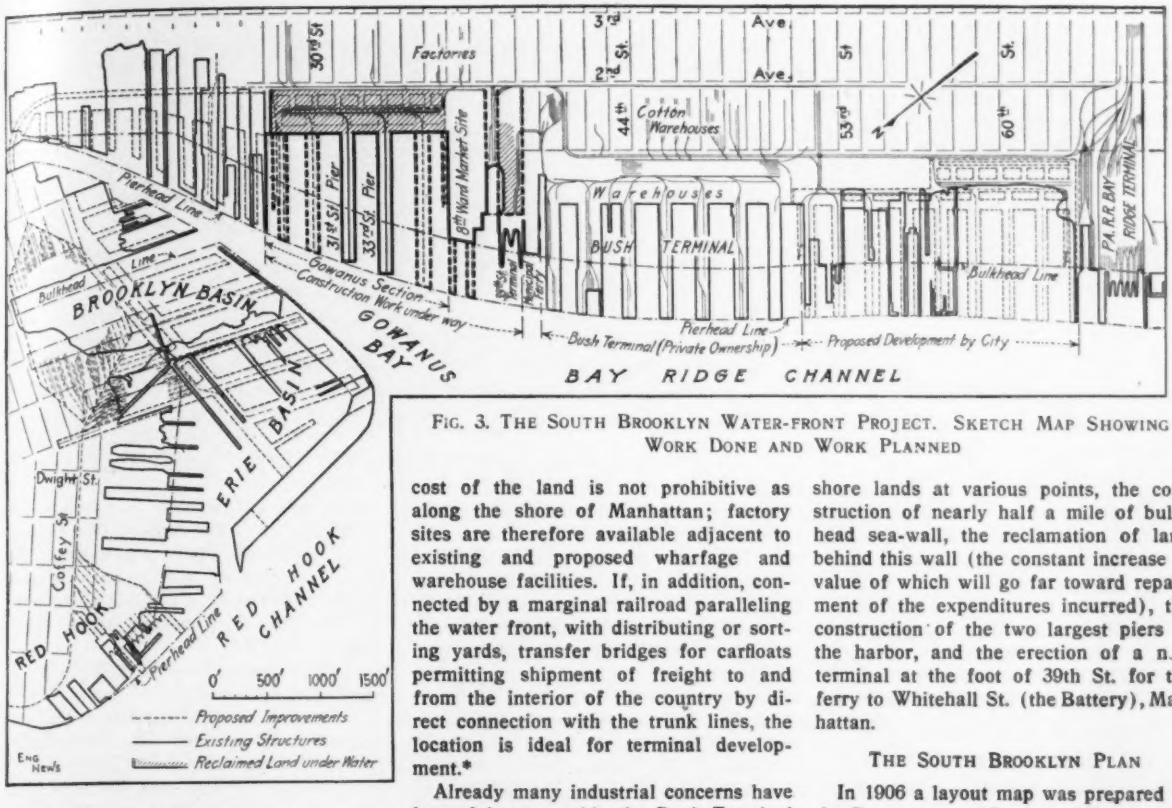


FIG. 3. THE SOUTH BROOKLYN WATER-FRONT PROJECT. SKETCH MAP SHOWING WORK DONE AND WORK PLANNED

also been often demonstrated that the creation of new facilities for commercial or industrial operations induces the initiation of new establishments and stimulates the growth and expansion of the old.

It seems to be the desire of the chief transatlantic passenger lines to dock in Manhattan, for it is here that the great hotels, commercial establishments, railroad terminals, places of amusement, etc., are located, which are consequently more easy of access to passengers. That this is sufficient reason for concentrating the ocean-ferry service in Manhattan, seems doubtful; other available localities in the harbor are closer to the heart of New York than the landing places of the same lines at European ports are to their respective centers. Thus, the South Brooklyn district will, on completion of the subway now under construction along Fourth Ave., be within 20 min. travel of 42d St., Manhattan. A removal of one or more of these lines to South Brooklyn would result in little change in location of the center of activity of the hotel and kindred business. Manufacturing and commercial establishments, on the other hand, would be attracted to South Brooklyn because of lower rents and real-estate values. These concerns are now driven to seek factory sites in New Jersey or Long Island.

The South Brooklyn shore possesses many of the desirable features for industrial and commercial development. The cost of the land is not prohibitive as along the shore of Manhattan; factory sites are therefore available adjacent to existing and proposed wharfage and warehouse facilities. If, in addition, connected by a marginal railroad paralleling the water front, with distributing or sorting yards, transfer bridges for carfloats permitting shipment of freight to and from the interior of the country by direct connection with the trunk lines, the location is ideal for terminal development.*

Already many industrial concerns have located here, notably the Bush Terminal Co., which has constructed a series of modern uptodate factory buildings with power, supplementing their system of freight steamship piers and storage warehouses, the whole connected by a marginal railway, sorting yard and transfer bridges for carfloats. The development of the South Brooklyn water front proposed by Commissioner Tomkins in his comprehensive report contemplates the eventual municipalization, on an equitable basis for all concerned, of the entire shore from the Brooklyn Bridge on the north to the Pennsylvania R.R. freight yard at 65th St. on the south. This is to be accomplished by developing existing city property between 28th and 39th Sts. and at 61st St., gradually acquiring the existing private freight terminals, extending the marginal railroads north and south, operating these under municipal control, and constructing at various points carfloat bridges and additional ferries to Manhattan for drays and passengers. This gradual acquisition and extension will create eventually a great commercial harbor, while keeping abreast of the increase in commerce of the port.

A beginning has been made in this scheme of creating a modern freight harbor, by the acquisition by the city of shore lands at various points, the construction of nearly half a mile of bulkhead sea-wall, the reclamation of land behind this wall (the constant increase in value of which will go far toward repayment of the expenditures incurred), the construction of the two largest piers in the harbor, and the erection of a new terminal at the foot of 39th St. for the ferry to Whitehall St. (the Battery), Manhattan.

*As more fully described in the "Report on the Organization of the South Brooklyn Water-Front between Brooklyn and Bay Ridge," by Commissioner Calvin Tomkins of the Department of Docks, May 7, 1911. See also the map, Fig. 1, of the present article.

THE SOUTH BROOKLYN PLAN

In 1906 a layout map was prepared by the Department of Docks and Ferries, outlining the proposed location of a series of new piers between 28th and 61st Sts., South Brooklyn, with a marginal street 350 to 500 ft. wide extending along the water front behind these piers. This map included the location of a new ferry terminal for the 39th St. ferry.

This general location plan was approved by the Sinking Fund Commission, and its outlines (as amended in 1908) became a part of the map of the city. The plan as then laid down is incorporated in the scheme of South Brooklyn development shown by the sketch may, Fig. 3. Subsequently in March, 1908, active operations were begun by the acquisition by the city of the water-front lands between 28th and 36th Sts., 38th and 39th Sts., and 60th and 61st Sts., respectively north and south of the Bush Terminal Co.'s plant.

The realization of the plan has been started by extensive construction work, begun in April, 1909, between 28th and 36th Sts. (Gowanus section), and by the reconstruction of the 39th St. ferry terminal. While this work can be regarded as a nucleus for the gradual expansion contemplated, it is self-contained and of independent value.

The work completed up to the present is described in the following.

THE NEW FERRY TERMINAL

Reconstruction of the ferry terminal at 39th St. was begun November, 1906, and

was completed March, 1908. Its total cost was $252,000. The ferry bridge and house were removed from their old location near Second Ave. to a new location 1000 ft. outshore. The work comprised:

1. Building a pile-and-timber platform about 1000 ft. long by 50 ft. wide for a temporary roadway to the new ferry location.

2. Constructing 250 lin.ft. of crib bulkhead with concrete retaining wall at the outshore end of this road to form the bridge seat for the new ferry substructure.

3. Constructing the new substructure: Three platforms on piles, with reinforced-concrete deck; two buffer and spring platforms on piles; two side and one center ferry rack, forming two slips 430 ft. long, which were dredged to a depth of 18 ft. at mean low water; and under these platforms 45 concrete pedestals on piles, to support the future ferry house.

4. Erecting two steel gallows frames with hoisting machinery for two ferry bridges and two overhead foot bridges.

5. Placing two ferry bridges 76 ft. long, with pontoons. These were constructed at the site of the work.

6. Building temporary waiting rooms, ticket booths, etc., with electric light and water installation.

The concrete bulkhead wall on crib foundation, above mentioned, extends from the face of what was at the beginning of operations the bulkhead on the south line of 39th St., extended, to an old crib bulkhead extending in and outshore near the southerly line of 38th St., thus inclosing a basin approximately 1000 ft. long by 260 ft. wide with the old ferry slip at its inshore end.

Ferry service was not interrupted during the construction of the new terminal. The temporary team and passenger roadway was first constructed, then one-half of the crib and wall, followed by the completion of the northerly ferry slip and waiting rooms; during this time the old ferry boats ran inshore past the new construction work to their old slip, without mishap of any consequence. Upon completion of the north slip, it was given over to the ferry service, the inshore slip was abandoned, and the southerly half of the work was completed. Subsequently, by coöperation with the Department of Street Cleaning, the entire basin in rear of this wall, 1000x260 ft. and about 20 ft. deep, was reclaimed by filling with steam ashes; electric-railroad tracks were extended from Second Ave. to the new ferry, and a more permanent paved roadway, made necessary by the extremely heavy freight traffic over this ferry, was constructed upon the newly made land, over 1000 ft. in length. The reclaimed land is available for future development and has become very valuable.

Plans have been completed for a new modern ferry building, and the contract for its construction will shortly be advertised for bids.

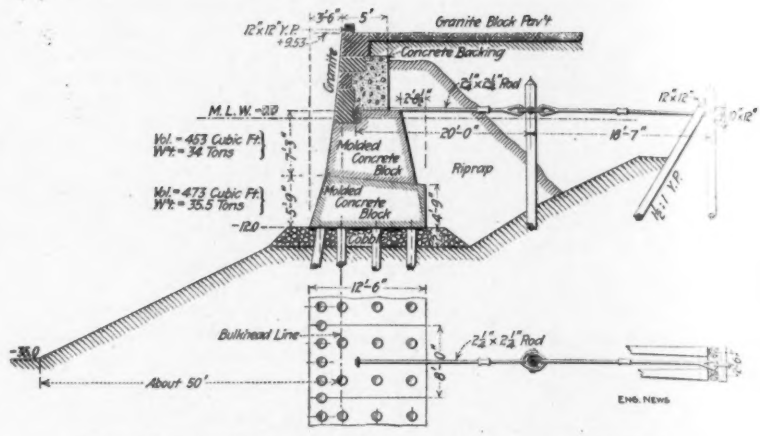


FIG. 4. TYPICAL BULKHEAD WALL, SOUTH BROOKLYN IMPROVEMENT

Fig. 10 shows some details of the new ferry bridge and pile racks. These are given not as representing any essential novelties, but as illustrating typical construction in this class of work.

THE GOWANUS SECTION PIERS

The Gowanus Section extends from 28th to 36th Sts.; its easterly limit is the west side of Second Ave., where an old crib bulkhead existed before the beginning of operations in April, 1909, and formed the shore line. The water over a zone averaging 300 ft. wide along this old bulkhead was at that time covered with wholly or partly submerged wrecks of canal boats, coal barges and other craft, and was, in short, a graveyard of derelicts, which had to be removed by the city. The view, Fig. 1, was taken at that time. In contrast, Fig. 2 shows the conditions after most of the work was done.

The work at Gowanus section comprises:

1. The construction of 2143 lin.ft. of bulkhead wall.

2. Dredging the entire area included between the pierhead line (here distant outshore from 1200 to 1850 ft.) and the established bulkhead line, from an average depth of 4 ft. to a depth of 35 ft. at mean low water in the proposed slips (of which there are seven) and 15 ft. over the pier sites. Approximately 4,000,000 cu.yd. of material was removed.

3. Constructing five piers, ranging in length from 1200 ft. to 1780 ft. Two of these are now completed, one 1475 ft. in length at the foot of 31st St., the second 1616 ft. long, at the foot of 33d St., both being 150 ft. wide. They are the

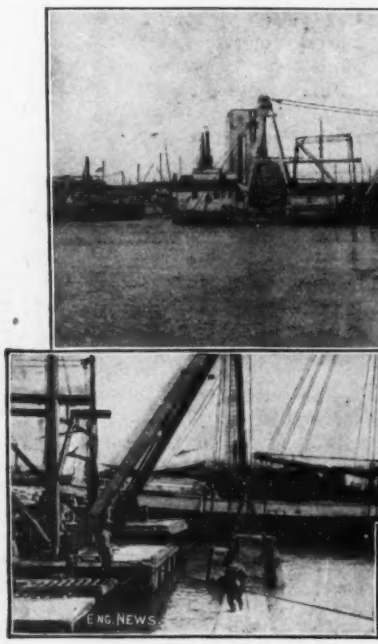


FIG. 5. SETTING CONCRETE BASE BLOCKS OF BULKHEAD WALL

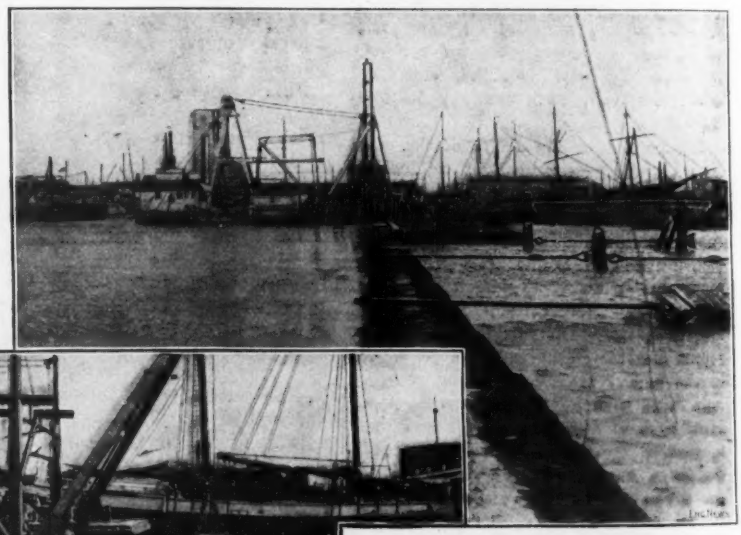


FIG. 6. THE GOWANUS BULKHEAD WALL AND ITS ANCHORAGE, BEFORE FILLING

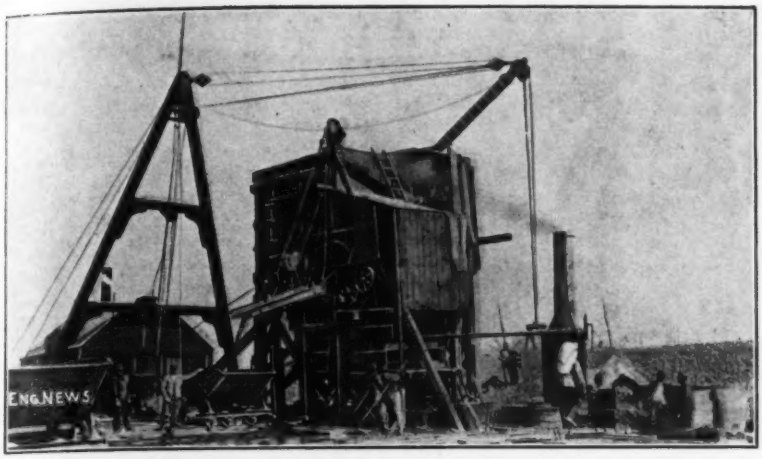


FIG. 7. DERRICK, CONCRETE MIXER AND BUCKET CARS, FOR DECK CONCRETING

largest piers in the harbor, and probably the largest piers of their type in the world.

4. Reclaiming the land under water behind the new bulkhead wall, by filling.

5. Paving (granite) the marginal roads along the bulkhead wall, with connecting paved roadways leading from Second Ave. over this newly made land to each pier site.

6. Erecting steel pier sheds over both piers, the shed construction of 33d St. pier being now under way. The 31st St. pier has been in use for the past 1½ yr. by the Fabre Line, engaged in the Mediterranean service; it has berthed as many as five steamers at one time.

The structures may, for purpose of description, be classified under the following heads: Marginal street or area, bulkhead wall, piers, pier sheds, general.

Marginal Street or Area—The physical shore line on the beginning of actual construction work in March, 1909, was an old crib bulkhead along the westerly line of Second Ave. From this bulkhead to the pierhead line is an average distance of about 2000 ft. A new bulkhead line, or limiting line for solid filling, was established 500 ft. outshore of the old crib above mentioned, and on this line, in the open water, was constructed a concrete and granite bulkhead sea wall. The basin formed back of this wall, 2143 ft. long by 500 ft. wide, with an average depth of water at mean low tide of about 3 ft., was filled to a height of 10 ft. above mean low water, mainly with material obtained from the subway-construction work under way along Fourth Ave. two blocks east of Second Ave., the subway contractors paying the city for the privilege of depositing this material. It will be noted that, in contrast to the Chelsea pier work, where it was necessary at great expense to cut back into the upland and remove existing structures in order to obtain space for long piers, on the Gowanus a large area was added to the city shore front by filling in land under water. The magnitude of the area thus reclaimed becomes clearer to the mind when we consider that it contains 403 city lots; that if the present 60-ft. street system in this locality from 28th to 36th Sts. was continued across the marginal area from Second Ave. to the paved roadway 60 ft. wide along the new bulkhead wall, there would result eight blocks 200x440 ft. This area is as level as a table, and presents a magnificent opportunity for warehouse sites, sorting yard, etc. Its market value is constantly increasing through the rapid industrial development of the adjacent upland.

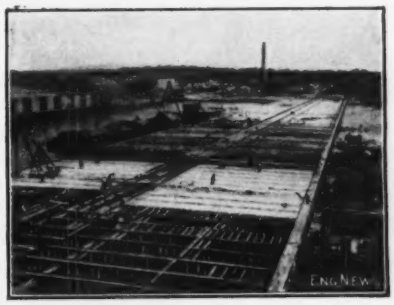


FIG. 8. CONSTRUCTING THE REINFORCED-CONCRETE DECK OF 33D ST. PIER, SOUTH BROOKLYN

Along the southerly line of 28th St. a temporary crib bulkhead was placed, 500 ft. in length, extending from Second Ave. to the new bulkhead wall, its purpose being to retain the earth filling at this end of the new marginal land until the same is extended northerly. The work of filling is practically finished, only a small area near 28th St. remaining uncompleted. The marginal area is available for short-term leases to manufacturers and others, pending the permanent development of the land.

Bulkhead Wall—On the new bulkhead line, 500 ft. from the old shore line, 2020 lin.ft. of concrete and granite sea wall was constructed. Wash borings and test piles were driven over the area of the wall and pier sites, upon the result of which the designs were based. The type of wall built is shown in Fig. 4. It is somewhat lighter than that adopted in other localities in New York harbor.

The bottom here is in general more stable and firm, consisting of sand of

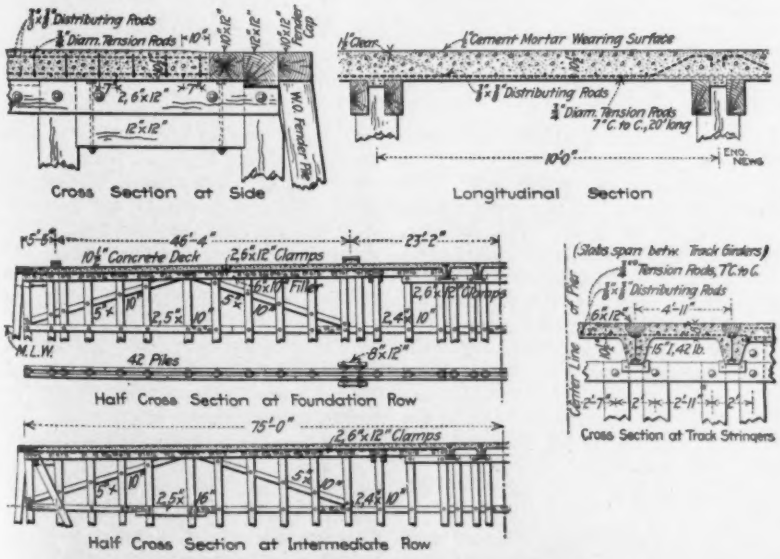

Cross Section at Side
Longitudinal Section
Half Cross Section at Foundation Row
Half Cross Section at Intermediate Row
Cross Section at Track Stringers

FIG. 9. PIER CONSTRUCTION, 33D ST. PIER

various degrees of coarseness from fine sand to coarse gravel, with layers of red and blue clay at intervals. This permitted the driving of piles practically to refusal with minimum penetration, except for a length of about 200 ft. of wall, where a soft pocket was found, necessitating the construction for this distance of a relieving platform behind the wall.

The wall proper is 12½ ft. wide at the base, and consists of concrete base blocks each 8 ft. long by 12½ ft. wide (see the view, Fig. 5), each block placed on a foundation of 10 piles. The blocks extend vertically from 12 ft. below mean low water generally to 0.53 ft. below mean low water at the face, a parapet at the back of the block rising to 1 ft. above mean low water. In order to facilitate the handling of these blocks by a floating derrick of 40 tons capacity they were made in two sections, a lower and upper half, weighing, respectively, 35.5 tons and 34 tons, or a total weight of 69.5 tons for each 8 ft. of base. The bottom was dredged to a depth of 12 ft. at mean low water, and piles were then driven over the area of the wall and cut off at 12 ft. below mean low water by a steam circular saw. The bottom was then leveled to the top of the piles with small cobble, a 3-ft. berm being added at both front and rear of the base-block seat. Upon these piles and cobble was placed a mattress of cement mortar, which in turn received the base block. From the top of the base block, the wall is carried up 5 ft. in width to 7.03 ft. above mean low water with a granite face and concrete backing; on top of this is placed a granite coping 2.5 ft. high, except at pier sites, where the wall above the top of the base blocks is all concrete.

The wall is divided into panels averaging 80 ft. in length by vertical joints extending through the entire cross-section, each panel being braced against sliding, during filling operations, by two braced anchors consisting of 2¼x2¼-in. steel rods, 40 ft. long, anchored into the wall and base blocks by 12x12-in. steel plates ¾ in. thick, and extending inshore to anchor clusters of vertical and brace piles. Forty such anchors were placed, averaging 50 ft. apart. The halftone, Fig. 6, shows this anchorage before earth was filled in. Provision was made to carry future sewers and drains through the wall under the proposed piers and in the slips by forming the necessary openings. Mooring posts were set at intervals along the wall on reinforced-concrete bases, tied into the sea wall, and a 12x12-in. yellow-pine backing log, supplied with mooring cleats, is now being placed along the outer edge of the coping.

The rear of the entire bulkhead wall was back-filled with riprap stone with a top width of bank varying from 4 to 10 ft. A total length of 2022 lin.ft. of wall has been completed. About 600 lin. ft. of coping remain to be set.

The unusual length of wall work making the installation of special machinery economical, a derrick and concrete mixer were rigged up on a department scow, and this machine was used in placing the mass concrete of the wall at the pier sites, and in setting the granite wall and backing it up with concrete.

A stiff-leg derrick with 40-ft. boom, of 6 tons capacity, with double-drum hoisting engine and vertical boiler, was mounted on a movable platform on rol-

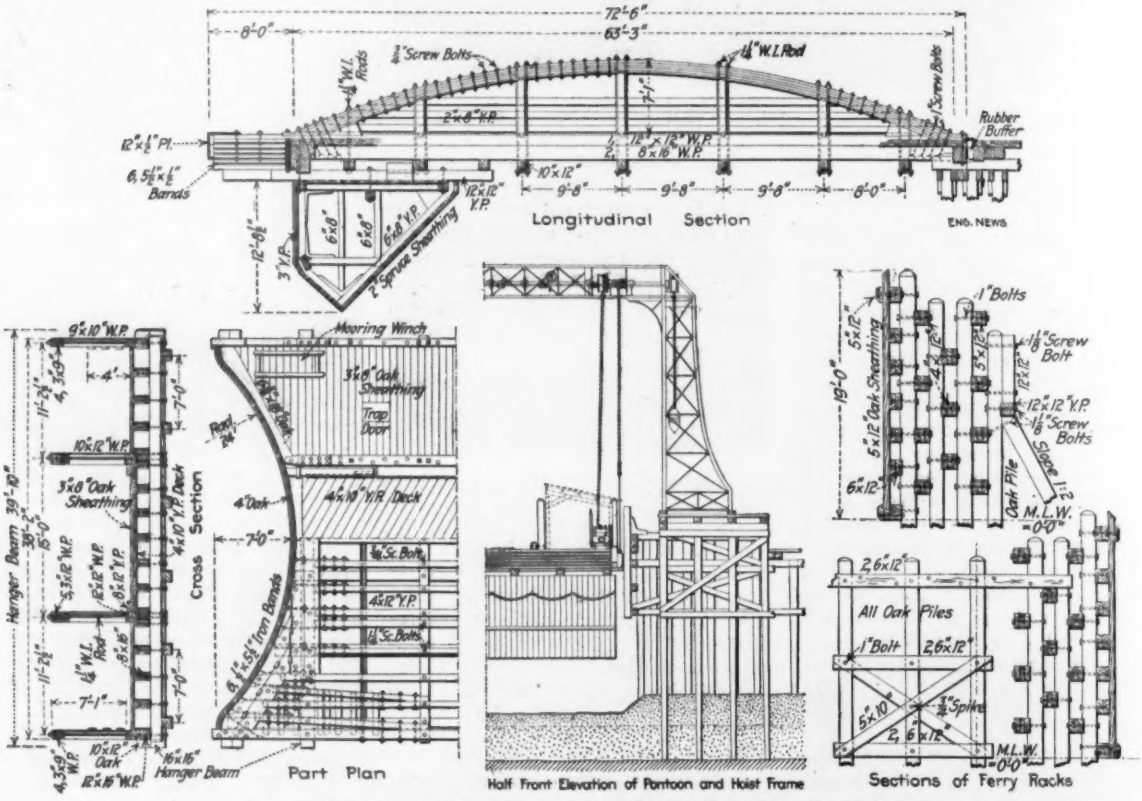


FIG. 10. DETAILS OF FERRY BRIDGE AND RACKS, NEW 39TH ST. FERRY

lers, placed on the after end of a deck scow 80 ft. long by 40 ft. beam; on the forward end of this scow, blocked up above the deck close to the port-side rail, was placed a Ransom 1-yd. rotary concrete mixer with vertical engine and portable boiler, the whole raised above the deck with timber blocking. Ordinary department deck scows, 30x70 ft., were then each loaded with about 100 batches of concrete material, sand at one end and broken stone at the other, cement in barrels near the center of the scow. The derrick lifted a 1-yd. steel bucket loaded with broken stone and a second loaded with sand and cement mixed in the proper proportions dry, and dumped them consecutively into a wooden receiving hopper built over the mixer, which discharged directly into the concrete wall

forms or molds through a sheet-iron swinging chute. When used to set granite wall stones, these were loaded directly on the derrick scow itself and placed within the reach of the boom; the granite was set in courses generally the length of a panel, averaging 80 ft., and immediately backed with concrete; the lowest course was set on the last half hour or hour of a falling tide, in order that all concrete work could be done clear of the water, and the capacity of the plant enabled it to keep ahead of the rise of the tide.

The first record of this machine was 244 batches (1 batch = ⅝ cu.yd.) of concrete, 1:2:4, placed in two separate forms, in 16 hours, or an average of 15¼ batches per hour. This time included the shifting of derrick and material scows and the adjustment of chutes for rise and fall of tide, etc.

The derrick was also used to advantage in placing the concrete forms, which had to be made heavy and substantial on account of the severe wave action of the water due to westerly winds at this locality.

The entire work on the bulkhead wall was done by the force of the Department of Docks and Ferries. It was begun on Apr. 13, 1909, and completed to under coping on June 30, 1911.

Piers—It is proposed to build five great piers on the Gowanus section, their length varying from 1200 to 1780 ft. Two of these have been completed, one at the foot of 31st St., 1475 ft. long, the second at the foot of 33d St., 1616 ft. long, each 150 ft. wide. Wash borings and test piles were driven to determine the nature of the foundation, and an exhaustive investigation was made to determine the possible destructive action of submarine wood-boring animals, teredo, limnoria, etc., before the type of structure was decided upon.

The piers do not differ materially in type of construction, and present little novelty in design of the substructure (see Fig. 9). The decks, however, are a new departure, being entirely of reinforced-concrete construction. The substructure of the piers is of the clamped-pile system. On 10-ft. centers, longitudinally of the pier, transverse pile rows were driven; the piles, cut off generally at the under side of the deck, were shouldered and tenoned at the top to receive two clamp timbers of 6x12-in. yellow pine spaced 6 in. apart. The spaces between piles in the row were chocked with 6x10-in. fillers set flush with the bottom of the clamp, thus leaving a 2x6-in. recess in the top of each clamp row to receive part of the deck concrete. The pile rows are braced transversely by horizontal and diagonal bracings of 5x10-in. yellow pine extending up from mean low water, and by brace piles driven at each end of the pile rows except in foundation rows. In every alternate row, i.e., 20 ft. c. to c. longitudinally of the pier, additional piles were driven to carry the future columns of the steel pier sheds.

The outshore end of the piers for a length of about 25 ft. is reinforced by two layers of 12x12-in. longitudinal rangers of 3-ft. centers, placed on top of the clamps of the pile rows, here doubled. These in turn carry a 6½-in. reinforced-concrete deck. Three lines of 10x12-in.

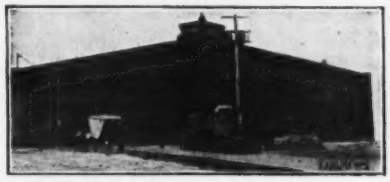


FIG. 11. NEW FREIGHT SHED ON 31ST. ST. PIER, SOUTH BROOKLYN

yellow pine side rangers extend along each side for the entire length of the piers, on top of the clamp system; to these are fastened mooring posts, bitts and cleats at intervals. At the center of the piers the clamp system was lowered in order to form a seat for four lines of 15-in. steel I-beams and 6x12-in. yellow-pine track stringers extending nearly the full length of the piers, their function being to form the support for a future double-track railroad. The 6x12-in. track stringers are removable, enabling the setting of future T-rails flush with the deck surface.

The reinforced-concrete deck, also shown in Fig. 9, extends from the side rangers across the full width of the piers. It was designed to carry a load of 500 lb. per sq.ft., and consists of a reinforced-concrete slab, 10½ in. thick, designed for the 10-ft. span between pile rows. It was made of 1:2:4 portland-cement concrete reinforced with ¾-in. round steel rods, 7 in. c. to c., 20 ft. long, staggered so that only alternate rods terminate on the same pile row. The deck was built with a crown of about 8 in. to shed the water. The inshore end of the concrete deck rests on the bulkhead wall but is not attached thereto, a horizontal plane joint allowing the deck to slide on the wall as it expands or contracts through changes of temperature.

Oak fender piles are driven at the ends of each pile row along both sides of the pier, and clusters of oak piles are driven at the sea end to protect the pier, which is in addition sheathed at its outer end with 6-in. yellow pine for the same purpose. Concrete pedestals provided with anchor bolts were placed on the deck, tied into the floor slab, to receive the future shed columns.

Two lines of longitudinal stiffeners occur in the 33d St. pier substructure, each consisting of two 6x12-in. yellow pine clamped to the piles. They are placed against the under side of the transverse clamps 40 ft. apart and extend throughout the length of the pier symmetrically with respect to the center line.

The pier is divided into five "fire zones" by four reinforced-concrete fire-walls extending from side to side of the pier and from low water to the under side of the deck, thus acting as fire stops. Two lines of fire manholes occur in the deck, so that every part of the substructure is accessible for fire fighting. These manholes are about 50 ft. apart. The concrete deck will be covered with an asphalt wearing surface for team traffic.

The views, Figs. 7 and 8, further illustrate the reinforced-concrete deck, and the plant used in placing it.

Pier Sheds—The steel shed placed on the 31st St. pier and that now in course of construction on the 33d St. pier are practically identical in design (see view, Fig. 11). Such modifications in the steel construction of the latter as occur are of minor importance and will be noted in the description.

The sheds are 141 ft. 8½ in. wide, leaving a 5-ft. space on each side of the pier as a passageway. Both sheds are single-story structural-steel frames covered with corrugated or crimped galvanized-steel siding and a five-ply tar-and-slag roof placed on 1½-in. spruce tongue-and-grooved roof boards. The roof is provided with four rows of galvanized-steel skylights, 6x10 ft., glazed with obscured wire-glass; 26 galvanized-steel ventilators 36 in. in diameter are placed along the ridge of the roof at equal intervals.

The frame consists of transverse bents 20 ft. apart, each composed of four columns, two side trusses and a center truss, with knee braces. The roof trusses are designed to carry a total load of 70 lb. per sq.ft. roof surface and to support possible future overhead walkways, the reaction of future cargo-hoists, etc. Longitudinally the transverse bents are connected by lattice-girders at the top of the columns on each side of the shed, longitudinal brace-frames connecting the interior columns, and a lattice-strut or girder along the ridge. Alternate bays have diagonal tie-rods in the plane of the roof. Some details are included in Fig. 12.

The roof is carried by 10-in. channel purlins riveted to the vertical truss members so as to bring their greatest dimension vertical. Nailers of 3x4-in. spruce bolted to the purlins receive the roof plank.

Horizontally sliding doors 20 ft. wide by 20 ft. high occur in every alternate

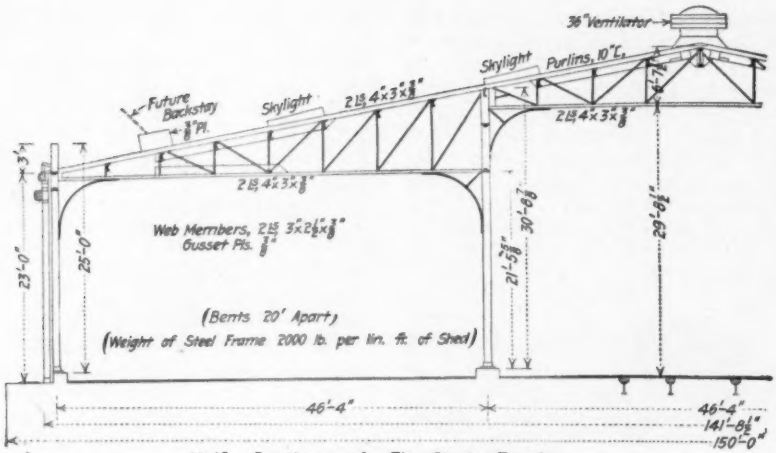


FIG. 12. OUTLINE SECTION OF PIER-SHED

panel on each side of the sheds. The sides of the sheds are formed by a steel frame made up of 8-in. channel door jambs forming the door openings, with four lines of 5-in. horizontal channel girts for fastening the corrugated-steel siding in the closed panels. This framework is set 4 in. outward of the side columns, thus forming a space for the doors to run in. The doors are hung on adjustable hangers and are made of 2⅛-in. white-pine frames covered with No. 20 galvanized crimped sheet metal; they are made in two halves. Two lines of heavy yellow-pine fenders are placed over each door opening to protect the shed from damage by cargo.

The roof is drained through 5-in. leader pipes alternately 40 and 60 ft. apart along each side of the shed, the side walls extending above the roof about 1 ft. to permit the framing out of sloping gutters to the leaders, which extend through the concrete deck of the piers.

The inshore and outshore ends of both sheds are similar in design and are composed of a structural-steel framework covered with ornamental galvanized-steel covering, formed with cornices, pilasters, etc., the base courses being of cast-iron and steel plate. Circular and rectangular windows and three sets of entrance doors are placed symmetrically. The apex of the roof is surmounted by a pediment with flag pole.

The 31st St. shed is provided with cargo-hoisting columns and cables placed on each side along the length of the shed. These were omitted on the 33d St. shed, provision for their future installation being made, however, by extending the side columns above the roof and riveting plates to the girders to which future backstays can be attached. Similarly an overhead passenger walkway suspended from the center truss of the 31st St. pier and extending nearly the length of the shed has been omitted in the 33d St. design, provision, however, being made for future installation.

Both piers are provided with a system of water-supply pipes. The main pipe, 8 in., rises from the meter placed near the inshore wall, to just below the ridge line of the trusses, and runs under the ridge to near the outshore end of the sheds. Ten transverse connecting branches of 3-in. pipe with valves and fire-hose couplings attached run from this main to the sides of the shed, to within about 4 ft. of the deck of the pier. Steel fire curtains placed in the roof construction, extending from the roof planks to the bottom chord of the trusses, divide the pier into five sections; they are essentially corrugated sheet-steel partitions following the lines of the roof trusses from the under side of the roof plank to the knee braces. An automatic sprinkler system, complete with all necessary valves and appurtenances, is also being installed in the 33d St. shed, this system supplemented by the fire-walls and manholes being a factor in the reduction of insurance rates on cargo and vessels occupying the pier. The under side of the roof plank will be painted with fire-retarding paint.

The general dimensions are shown in Fig. 12. The frame of the 31st St. shed is shown during erection by the view, Fig. 13.

It being necessary to build both piers and sheds at the lowest possible cost, economy has been the object aimed at in the design of these structures. Some of the general requirements of the specifications under which the work was done are: All galvanized iron is washed with lye after delivery on the work, then cleaned with water and dried, after which the priming coat of paint is applied, followed by two further coats. The structural steel is painted one coat at the shop and two coats after erection; all field connections are painted with graphite paint before placing. The roof is guaranteed for one year against possible leaks or defects. The deck of the pier is to be covered with an asphalt wearing surface. The water-supply and sprinkler-system installations must comply with the rules and regulations of the Board of Fire Underwriters and the Fire Department. Water-supply pipes are covered with hair-felt covering to prevent freezing, as are also the sprinkler pipes where holding water. The sprinkler system is provided with an automatic alarm and annunciator indicating the location of fire.

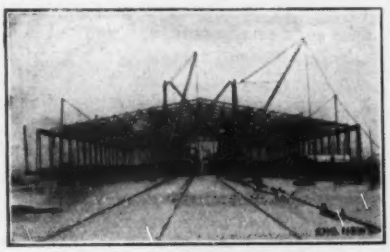


FIG. 13. ERECTING FRAME OF PIER-SHED ON 31ST ST. PIER

No cargo-handling machinery or apparatus has been installed in the 33d St. pier, such installation as may be required by their particular class of cargo being left to be done by the future users at their own expense and convenience. The possibility of the construction of future overhead passages, the installation of cargo hoists, and light conveyors, etc., has, however, been taken in consideration in the design of the steel structures.

The cost of the pier sheds is tabulated below:

COST OF CONSTRUCTION OF PIERS AND SHEDS

	Contract price
31st St. pier, 1475 x 150 ft. Contractor, H. R. Wheeler	$178,561
31st St. pier shed, 1452 x 141 ft. 8½ in. Contractor, Chas. Meads & Co.	155,790
33d St. pier, 1616 x 150 ft. Contractor, H. R. Wheeler	236,500
33d St. pier shed, 1593 x 141 ft. 8½ in. Contractor, Snare & Triest Co.	220,980
39th St. ferry terminal, Brooklyn Contractor. Bernard Rolf	252,000

General—Wash borings have been driven to determine the nature of the bottom over the entire area covered by the proposed water-front improvements from the entrance of the Erie Basin on the north up and down both shores of Gowanus Bay and Canal to 28th St., where the Gowanus-section work (the above described work) begins. Similar investigation has been made south of 51st St., South Brooklyn.

It is of importance to note the so called Eighth Ward Market site, extending outshore south of the foot of 36th St. in the heart of the proposed water-front development (see Fig. 1). Under the jurisdiction of the borough president of Brooklyn, here has been filled in a large tract of water front upon which it is the intention to build a vast public market at a total cost to the city of $3,200,000.

Authorities—The improvements herein described are being carried out by the

city through its Department of Docks and Ferries.

The preparation of general plans and designs was begun in 1906 under John A. Bensel, Commissioner of Docks, and continued under his successor, Allen N. Spooner. It is now being carried on under Calvin Tomkins, the present Commissioner of Docks, to whose efforts it is in a great measure due that the future needs of New York harbor have been widely placed before the public.

B. F. Cresson, Jr., and W. J. Barney are First and Second Deputy Commissioners, respectively. The work of construction is under the direction of Charles W. Staniford, Chief Engineer, Department of Docks and Ferries; S. W. Hoag, Jr., Deputy Chief Engineer; R. T. Betts, Assistant Engineer in charge of Design; Philip Guise, Assistant Engineer, in charge of field work at South Brooklyn.

Contents of a 6-in. Water Main, Springfield, Mass., Frozen Solid

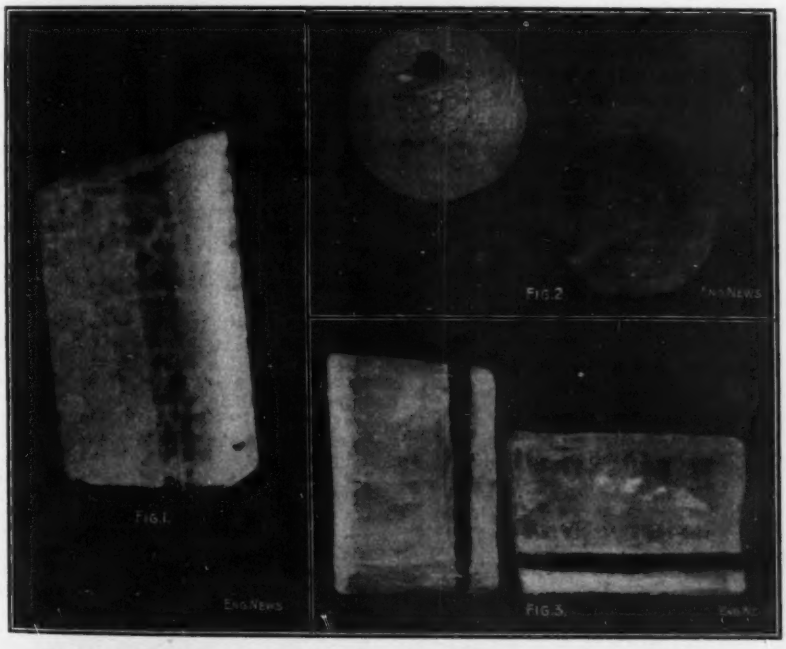
By Elbert E. Lochridge*

The freezing of the 6-in. water main in Oakland St., Springfield, Mass., developed some conditions which may be of interest to your readers. The 6-in. pipe at the Oakland St. crossing of Mill River at one time was the main feeder for an outlying section of the city. The pipe was of cast iron and was laid in 1892. The street at this point had considerable grade which had been reduced when the street was paved at some time without the knowledge of the water department, so that but 27 in. of cover, including the macadam surface, remained over the pipe.

Two years ago a 24-in. main was laid in this same street parallel to this 6-in. pipe. This had become necessary to supply the growth of the city in this direction. The 6-in. pipe was left in the street to supply the local services and to avoid the necessity of tapping the larger pipe. This undoubtedly resulted in reducing very largely the velocity of water in the small pipe, as it was no longer needed to feed this section. The failure on the part of an apartment block fed from this pipe to secure water on Jan. 27, 1912, resulted in a call upon the Water Department. Following an arrangement with the Electric Light Co. an electric connection was at once made with this pipe and the ice was thawed out and service restored, and it was arranged that water was to be permitted to run in this apartment to prevent further freezing of the main. A few days later, however, the same call came in again and it was found this time that the main had been broken in freezing. The street was accordingly opened, and the pipe taken out. On taking out the pipe the ice was found to be solid throughout its entire length and perfectly clear with the exception of a circle about 1 in. in diameter and 1 in. above the bottom of the pipe. This dark spot extended, as can be seen in the views, throughout the entire length of the pipe. The radial lines indicate that this was probably the last point frozen. As can be seen from the pictures, all of the iron rust and tubercles, which have been forming during the twenty years of service of this pipe, are concentrated in the freezing of this mass, and not the slightest trace of iron rust can be seen in the periphery of the ice. The pipe itself apparently had been entirely cleared by the ice and all of the iron rust deposited at one point. No particles of this rust could be found at any point in the ice between the central cylinder of rust and the circumference.

Three pictures were taken. Fig. 1 shows a section of this ice 6 in. in diameter just as it was picked up on breaking the pipe by sledge hammers. The clearness of the ice can be noted and the freedom from any material frozen into it at the point of its contact with the cast iron. Fig. 2 shows this same cake sawed in section, the section on the right being a cylinder of ice 1½ in. thick, to show the crystallization lines of the ice. The section on the left is an end view of the same piece of ice from which the section was cut. Fig. 3 shows this same section sawed longitudinally. The dark section was composed of as firm ice as any in the cylinder. It was largely made up of the tubercles and iron rust usually found on the interior of cast-iron pipe of this age.

*Chief Engineer Water Department, Springfield, Mass.



FIGS. 1 TO 3. VIEWS OF 6-IN. CYLINDER OF ICE FROM A 6-IN. WATER MAIN, SPRINGFIELD, MASS.

(Fig. 1 shows the ice as it froze against the interior of the pipe. The end elevation and cross-section, Fig. 2, and the longitudinal sections, Fig. 3, show the concentration of rust and tubercles within the ice cake, as explained in the text.)

The Benefits of Irrigation and allied improvements in the Salt River Valley, near Phoenix, Ariz., supplied with water from the reservoir formed by the famous Roosevelt Dam, are thus stated in a press bulletin issued by the U. S. Reclamation Service:

The crops of 1911 had an estimated value of more than $5,000,000, or an average of $40 per acre. The increase in land values during the past six years has been amazing. In 1905 the assessed valuation of the taxable property in Maricopa County, which is practically the Salt River valley, was $10,866,435, and in 1911 it rose to $21,478,734 or nearly double. The Salt River Valley Water Users' Association, composed of the landowners on the project, now has a membership of 2657, an increase of 829 members in two years. This association, in a few years will assume full charge and management of the project, will operate and maintain the elaborate canal and pumping system and a large power plant, costing more than a million dollars, which is now delivering power to all the municipalities of the valley. These great public utilities, the irrigation system and the power plant, are to become the property of the farmers, to be managed by them for their benefit and profit. The large surplus of power which is being developed is already in demand for trolley systems which are now being extended to all parts of the project, and by numerous manufacturing enterprises. Several of the municipalities are now being lighted from this plant. This experiment in community ownership and control of these important utilities will be watched with interest by people all over the country and especially by those who are residing in the arid country. Coöperative management of the irrigation system is a fundamental principle on all of the Government projects. The inevitable tendency of such management has been coöperative organization, which today is being extended to all of the farmer's activities, individual, educational and social. The arid West is solving the great problem of keeping the people on the land by making country life sufficient.

An Improved Locomotive Firebox

Improvement in fuel economy and engine efficiency, with reduction in boiler repairs, is aimed at in the locomotive firebox described. Instead of a separate combustion chamber, as used in some engines, this firebox has a chamber formed within it by means of a firebrick bridge wall, and provision is made for the supply of air through this wall to the fire. Engines having this firebox are in use on two railways, and tests show satisfactory results in service.

The desirability of effecting complete combustion of fuel and gases in the firebox of a locomotive boiler is generally recognized, but difficulties are encountered in effecting this under the conditions of locomotive construction and operation. The firebrick arch and the combustion chamber are important auxiliaries in ensuring this complete combustion, but while they are used extensively their use is by no means general. The admission of air to the fire is necessary for good combustion, but on probably a large majority of locomotives, a considerable proportion of the trouble from leaky tube ends, cracked tube-sheets, etc., is due to the entrance of large volumes of cold air when the fire-doors are opened, this air chilling the hot plates and tubes, and (if in excess) lowering the efficiency of the combustion.

An interesting modification in firebox construction which has been designed to facilitate complete combustion, and which incidentally reduces boiler repair work, consists of placing a firebrick bridge-wall just in front of the tube-sheet. The products of combustion have to pass over the narrow space above this wall, and the space behind it forms a combustion chamber and spark trap, while the wall protects the tube-sheet from the attack of currents of cold air entering the fire-door. The wall is perforated and air is supplied to the firebox through these openings, so as to give an ample air supply and to deliver it (highly heated) at a point where it will act upon the fire without striking the plates or tubes. The construction referred to has been applied to a number of engines, with satisfactory results, as noted below. It has been invented and patented by F. F. Gaines, superintendent of motive power of the Central of Georgia Ry., Savannah, Ga. To him we are indebted for particulars and plans of the firebox, and for a record of tests made with one of the engines thus equipped.

The general construction is clearly shown in the accompanying cut, which shows its application to a wide firebox having a total interior length of 11 ft. 4 in. from back-plate to tube-plate. A cross frame carries the bridge-wall, which gives a clear length of 8 ft. 1 in. for the firebox proper (as before its modification and lengthening) and a combustion chamber 24 in. wide between the wall and the tube-plate. The bottom of this chamber is sloped to a spark hopper or chute fitted with a gate, as shown. The wall has five 2½-in. tubes which end at enlarged openings just below the overhanging top of the wall, so that the air entering is thrown into the hottest part of the fire. These tubes extend below the firebox, where they are turned to a horizontal position and fitted with trumpet-shaped mouths. The open space between the bridge-wall and the crown of the firebox has a maximum height of 16½ in.

This firebrick bridge-wall construction has been applied to a number of engines in both freight and passenger service on the Chicago Great Western Ry. J. G. Neuffer, superintendent of motive power, states that it materially improves the steaming capacity (where there is ample grate surface) and reduces the repair work on the tubes, but the device has not been in service for a sufficient length of time to allow of an opinion as to what effect it may have on the firebox plates. These engines have narrow fireboxes, 42¼ in. wide inside at the grate, with the usual mushroom section of the upper portion. The inside length from back-plate to tube-plate is 9 ft. 4 in., while the wall divides this into a firebox proper 6 ft. 6 in. long and a combustion chamber 20 in. long. No information is available as to the fuel economy on this road.

Tests of Fuel Economy

In regard to the question of fuel economy, however, we have been furnished by Mr. Gaines with a record of tests made on the Central of Georgia Ry., in January, 1911. The tests were made in freight service between Mason and Columbus, 100 miles, but a train of 18 steel cars loaded with company coal was used for all runs, so as to avoid complications due to changes in load and composition of the train. The weight of train was 1286.25 tons. All the engines were of the consolidation (2:8:0) class. No. 1014, with cylinders 21x32 in., had the construction shown in Fig. 1, and a total heating surface of 2987.33 sq.ft. No. 1012 was identical with No. 1014 except that it had the original boiler unchanged and a brick arch; its heating surface was 3,022.29 sq.ft. No. 1716 had cylinders 22x30 in., and its firebox had a brick arch; the total heating surface was 3230 sq.ft.

The same kind of coal was used on all engines and on all runs. It contained 1.55% sulphur, and the analysis was as follows: Fixed carbon, 55.11%; volatile combustible matter, 30.56%; ash, 12.94%; moisture, 1.39%. The heat value (by the Mahler-Atwater calorimeter) was 13,179 B.t.u. per pound of dry coal, or 12,996 B.t.u. per pound of coal actually used. The relative efficiency, based on coal consumption per mile and taking the equipped engine No. 1014 as 100%, was 61.96% and 85.88%, respectively, for the non-equipped engines Nos. 1012 and 1716. The excess in coal consumption as compared with the equipped engine No. 1014, was 15.94 tons for No. 1012 and 4.45 tons for No. 1716. A summary of the tests is given in the accompanying table.

To supplement the information given above, Mr. Gaines has furnished us with a copy of an article furnished by him recently to the *American Engineer*, and permitted us to make use of it. This matter (somewhat condensed) is given below, as explaining the general principle and purpose of the invention as well as its application in service.

A New Design for Locomotive Fireboxes

RELATION OF FIREBOX VOLUME TO COMBUSTION—In the study of combustion of fuel in locomotive boilers it would seem as if the value of firebox volume and heating surface have been lost sight of, or at least have not been given the weight that these features deserve. It would seem also that the effect of changing the path of the gases in the firebox, by means of either the brick arch or the combustion chamber with brick wall, has not been realized to the extent that it should be. While it is true that a few railways are using the combustion chamber and are consequently availing themselves of the increased firebox volume, the number so doing is comparatively small at the present time, although growing. This is equally true of the brick-arch situation. On the other hand, railways which have been using the combustion chamber (properly applied) for any length of time, are aware of the value of this feature; and this is equally true of the railways using the brick arch. Both of these devices add greatly to economy in fuel consumption and ability to generate a maximum amount of steam.

Personal experience with the Wootten type of firebox has convinced me that firebox volume and deflection of gases are important factors. A rather lengthy study of the whole matter resulted in a special design of firebox, embodying the combustion chamber, brick wall with air inlets, and means for cleaning the combustion chamber.

In the regular type of firebox for bituminous fuel, the flame seeks the shortest course to the tubes. It is more than probable that under the heavy forced draft the majority of the gases and flame pass to the tube-sheet some little distance below the top row of tubes. Under

these conditions the heating surface embodied in the back head and the back part of the crown-sheet and side-sheets absorbs a very small amount of the heat that it is capable of absorbing. Any attempt at complete combustion of the gases by the introduction of air in any manner stands very little chance of having the desired effect; the movement of the gases being so direct and no provision being made for deflection between the time they leave the bed of coals and enter the flue-sheet, where of necessity (due to the reduced temperature) any further combustion is stopped.

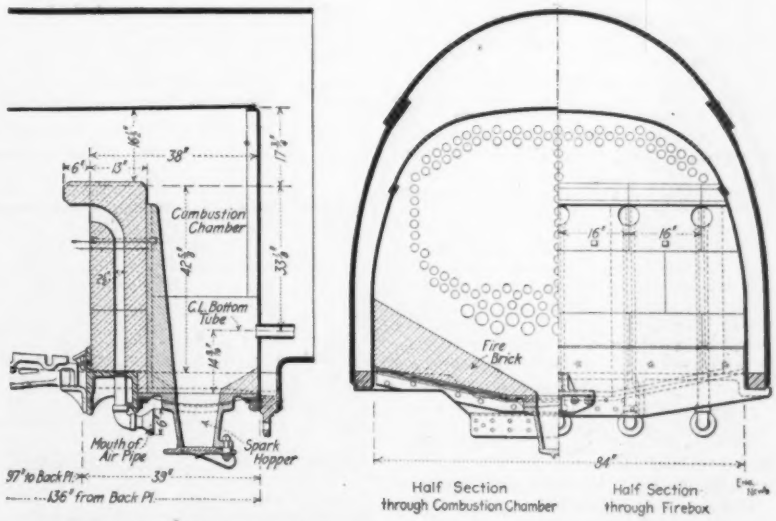
The introduction of the brick arch in this type of firebox brings about an entirely different state of affairs. The gases and flame rise from the fire and are thrown back, passing over the top of the arch and then to the tube-sheet By this means the heat has been brought in closer contact with that portion of the firebox at the rear, thus effecting considerable increase in the generation of steam. It is also easily seen that the introduction of air from any source would aid combustion and has much more opportunity for effecting this result, as the baffling of the gases by the brick arch gives a chance for the air to mix with the unconsumed gases and for the mixture to burn before striking the tube-sheet.

This arrangement, while effecting considerable economy over the plain arrangement, has its drawbacks when it comes to extreme widths of firebox; also where the wheels are under the firebox and limit its depth. In many cases the fireboxes on modern engines, especially the consolidation (2:8:0) type, are so shallow that it is impossible to get the arch between the tubes and the fire. In many other cases, owing to the width of the firebox, it is necessary to support the arch at two or more points with arch pipes.

Any cold air entering the plain firebox first mentioned stands a chance of striking the tube-sheet and cooling it to an extent that will give trouble with the tubes, whether entering from a hole in the front end of the fire or during a prolonged opening of the fire-door. With a brick arch that is solid against the front end there is little possibility of cold air entering the tubes, as the air becomes heated before striking the tube-sheet by mingling with the gases in passing over the baffle of the brick arch. In engines using the open arch, or one that is open at the tube-sheet, this would still hold true for the admission of air from the door, but any hole in the front end of the fire would again cause considerable trouble on account of leaking tubes.

In the Wootten firebox, additional firebox volume is obtained by the use of a circular combustion chamber surrounded by a water leg, and with a brick wall built up at the back end. More or less of the gases are thrown backward and upward, so as to obtain the same effect as with the brick arch noted above. It is evident also that as the brick wall is of some considerable height, the firebox itself may be as shallow as the design of the engine may require, as the brick wall prevents the fuel from getting into the tubes. Incomplete combustion is minimized in this arrangement, as any air that is admitted is more or less intimately mixed with the gases in passing over the brick wall, and has the opportunity of burning in the combustion chamber before striking the tube-sheet. Mechanically there are some objections to this arrangement. The water leg surrounding the combustion chamber must be of sufficient thickness (at the bottom especially) to allow good circulation and prevent the burning of sheets. This in turn cuts down the available tube-sheet area and prevents the installation of the same number of tubes that would otherwise obtain in a boiler shell of the same diameter. It also becomes necessary, at intervals, to cool off the boiler and remove the accumulation of sparks from the combustion chamber. However, for blowing out the tubes when they are choked, or working on the tubes when leaking, it is not necessary to dismantle the brick wall. There is another point that causes trouble, due to the junction of the throat-sheet with the side- and crown-sheets. This joint, coming in the hottest part of the burning gases, sometimes gives trouble from leaking. On the other hand, it is almost impossible to damage the tubes by cold air, either from a hole in the fire or from prolonged opening of the fire-door, as such air will be heated before striking the tube-sheet.

It is certain that with the Wootten firebox results are obtained in fuel economy, steaming capacity, etc., that cannot be obtained in the other two types above mentioned. It is more than probable that the increased firebox volume, together with the deflection of the gases by the brick wall, are the most important factors in producing these results.



LOCOMOTIVE FIREBOX WITH BRIDGE WALL AND COMBUSTION CHAMBER

(F. F. Gaines, Superintendent of Motive Power, Central of Georgia Ry., Inventor.)

FIREBOX WITH BRICK WALL AND COMBUSTION CHAMBER—The problem then is to find a design in which these factors can be maintained and the objections referred to eliminated. This was finally accomplished by the design shown [in the accompanying cut]. Here we have the increased firebox volume and deflection of gases from the rear, so as to utilize the back portion of the firebox; also the introduction of air through the brick wall, providing oxygen for complete combustion. This air, entering through the incandescent brick wall is heated approximately to the temperature of the firebox before mingling with the gases, making the most favorable conditions for permitting complete combustion. The space behind the wall allows an opportunity for the gases to burn before striking the tube-sheet. The arrangement permits of the application of a regular hopper at the bottom of the chamber for cleaning. It eliminates the seam between the throat and side sheet of the place where it is liable to give trouble; it also protects the tubes from cold air and consequent damage. The same tube-sheet arrangement may be obtained for the same boiler diameter as is obtained in the plain firebox.

TESTS OF FIREBOX—To check these theories with actual practice, an engine was changed [to the construction shown] by cutting off the entire back head, building a new back head, and building a brick wall on a cross bearing. The length in front of the wall was the same as the original length in front of the tube sheet. The engine was put into service in February, 1909. The tubes applied to the engine at that time have never given any trouble from leaking or stopping up. The engine has been in the shop twice for tire turning, but is still running with the original tubes, having made 80,000 miles. Sister engines on the same division, as well as engines of equal power in the same service, fail to make an average of over 26,000 to 33,000 miles before the tubes require safe-ending and resetting.

A series of tests, using this engine, a sister engine without combustion chamber, and a wide-firebox consolidation engine of later design and better proportions was made in March, 1909. An additional test was made in February, 1911. Both series of tests were made with the same crews, using a train composed of steel cars loaded with company coal, thus eliminating any variables due to makeup of train. All coal used in each test was from the same mine at the same time, and was sacked. The two tests check very closely and show almost identical results. It is evident from the results that the economy of the arrangement is actual and quite considerable. [The record of the later test is given in the accompanying table.]

OTHER ADVANTAGES—It has been found that when the fuel supply is of a nature which gives steam failures on other engines running in similar service on the division, this engine has not given

TESTS OF LOCOMOTIVES WITH DIFFERENT TYPES OF FIREBOXES; CENTRAL OF GEORGIA RY.

Actual time, h.m.	Stops No.	Time, h.m.	Coal Consumed Total, lb.	Coal Consumed Per 1000 ton-miles, lb.	Coal Consumed Per hour, lb.	Water Evaporated Total, lb.	Water Evaporated Per lb. of coal, lb.	Run per ton of coal, miles
Engine No. 1014. With Gaines Firebox								
6:34	6	1:04	11,950	93	1820	96,800	8.10	16.74
6:42	8	1:33	13,350	104	1991	109,000	8.16	14.98
6:12	7	0:49	12,450	97	2008	105,750	8.49	16.08
6:39	7	1:12	14,250	111	2143	109,800	7.71	14.04
26:07	..	4:38	52,000	101	1991	421,350	8.10	15.38
Engine No. 1012. With Ordinary Firebox and Brick Arch								
7:12	5	0:57	20,400	159	2833	121,458	5.95	9.80
8:04	5	1:16	21,900	170	2715	124,887	5.70	9.13
6:43	5	0:45	19,087	148	2841	113,095	5.93	10.48
7:20	8	1:43	22,500	176	3068	121,883	5.42	8.89
29:17	..	4:41	83,887	163	2865	481,323	5.74	9.54
Engine No. 1716. Newer engine, with Ordinary Firebox and Brick Arch								
8:00	9	2:33	15,000	117	1875	110,400	7.36	13.33
7:24	10	1:41	16,500	128	2230	120,000	7.27	11.43
6:50	9	1:20	13,800	107	2080	102,801	7.45	14.49
7:28	12	1:42	15,600	121	2089	117,166	7.51	12.82
29:42	..	7:16	60,900	118	2050	450,367	7.39	13.14

Efficiency based on coal consumption per mile: No. 1014, 100%; No. 1012, 61.96%; No. 1716, 85.58%.

a single steam failure, even when the grade of fuel was considerably below standard. This engine when in service working steam emits a minimum amount of smoke; in fact, it is almost impossible to make black smoke even by leaving both fire-doors open and shoveling coal continuously. On the other hand, with an ordinarily good fire the amount of smoke emitted is almost imperceptible.

Very few sparks are ejected from the stack, and those ejected in all cases are dead. On the other hand, there is no great accumulation in the combustion chamber, it being very seldom that more than a few quarts are found there. These latter sparks are readily removed through the hopper in the bottom. Another rather important feature connected with the burning of soft coal on this engine is that the tubes show no indications of choking. The foreman boiler maker of the terminal out of which this engine runs states that it has never been reported as requiring to have tubes blown out.

Billboards and Bill Posting in Hartford, Conn., are regulated by an ordinance passed some months ago and published in full in the report of the Commission on the City Plan for the year 1910-11. The ordinance prohibits the erection or maintenance of any billboard or outdoor advertising sign within the city of Hartford, upon any land or upon any building, without the written consent of the owner of private properties, or, in the case of city property, without the consent of the city of Hartford, in the form of a written permission from the mayor. Every person or corporation engaged in bill posting must secure an annual license from the mayor. The license fee for persons or corporations employing one or more men is $25 a year, and for any man engaged singly in the business $3 a year. Employing bill posters must file with the mayor a list of all boards owned or leased by them, together with their location and size. The ordinance contains provisions designed to prohibit the posting of bills or pictures of any kind which are immoral in character. The ordinance also contains provisions designed to provide for the safety of billboards and their maintenance in a neat condition. On complaint of any citizen to the effect that any bill poster is displaying offensive matter or maintaining a billboard in an untidy or unsafe condition it is the duty of the mayor to enforce the ordinance.

The Floating Caisson for Gatun Spillway Dam

By Edward C. Sherman*

The regulating works of Gatun Lake consist of a concrete overfall dam of ogee section, curved in plan, and a concrete-lined channel to take the discharge into the Chagres River below Gatun Dam. In order to obtain a large discharging capacity with a reasonable length of dam, the crest is divided by piers into 14 bays, each 45 ft. in the clear, and each bay is provided with a Stoney sluice gate which can be raised, permitting overflow to take place at a depth of 18 ft. The sluice gates are of steel and as it would not be permissible to lower the lake and interfere with navigation in the Canal in order to paint, repair an old or to place a new gate, a caisson will be provided which will close off the opening so that any gate can be unwatered.

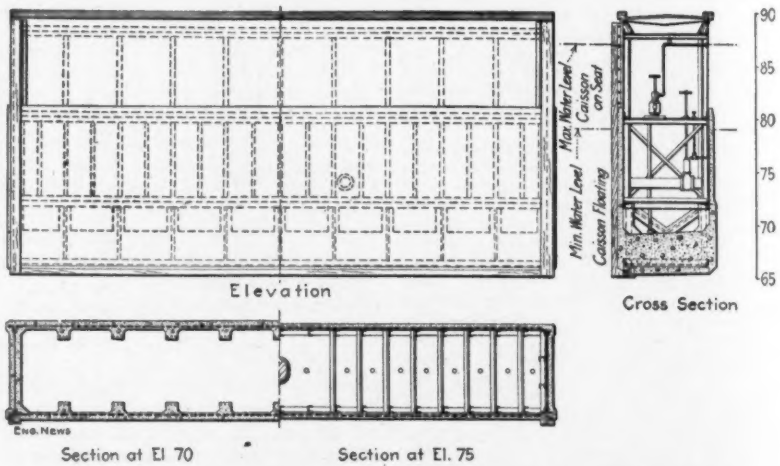


Fig. 1. Preliminary Study of a Concrete and Steel Caisson to be Used in the Unwatering of the Stoney Gates on the Gatun Dam

The procedure to be followed is briefly as follows: The caisson will be floated into its place behind the crest gate and water will then be admitted to the interior in sufficient amount to sink the caisson to its seat on the dam. Opening the sluice gate slightly will then result in the escape of the small amount of water between the gate and the caisson and will cause an unbalanced pressure on the upstream side of the caisson which will force it tightly against the vertical seats and permit very little leakage.

Upon the completion of the work on the gate, water will be readmitted to the space between the gate and the caisson by means of a pipe passing completely through the caisson, and the latter will be pumped out and towed away.

The caisson is essentially a box furnished with timber keels and sills to provide tight joints with the masonry seats of the spillway dam. Fixed concrete ballast causes it to float upright in the water and to have the desired draft and stability.

Study was made of two types of construction, reinforced concrete and steel. It was necessary to use longitudinal steel girders in either case, to span the long opening, and the first type, though called reinforced concrete, is so only in the use of slabs of that material as sheathing for those parts that would be inaccessible without docking. A preliminary design was worked out as shown in Fig. 1, but the all-steel caisson was preferred and was designed in detail. Elevations and sections of the latter are shown in Fig. 2.

It is proposed to erect the caisson near the upper lock at Gatun, on a site which will be submerged when the lake is filled, so that the caisson can be floated without the difficulty of launching.

As soon as the lake fills sufficiently and the caisson floats, it will be trimmed by

*Consulting Engineer, Boston, Mass., formerly Designing Engineer, Isthmian Canal Commission.

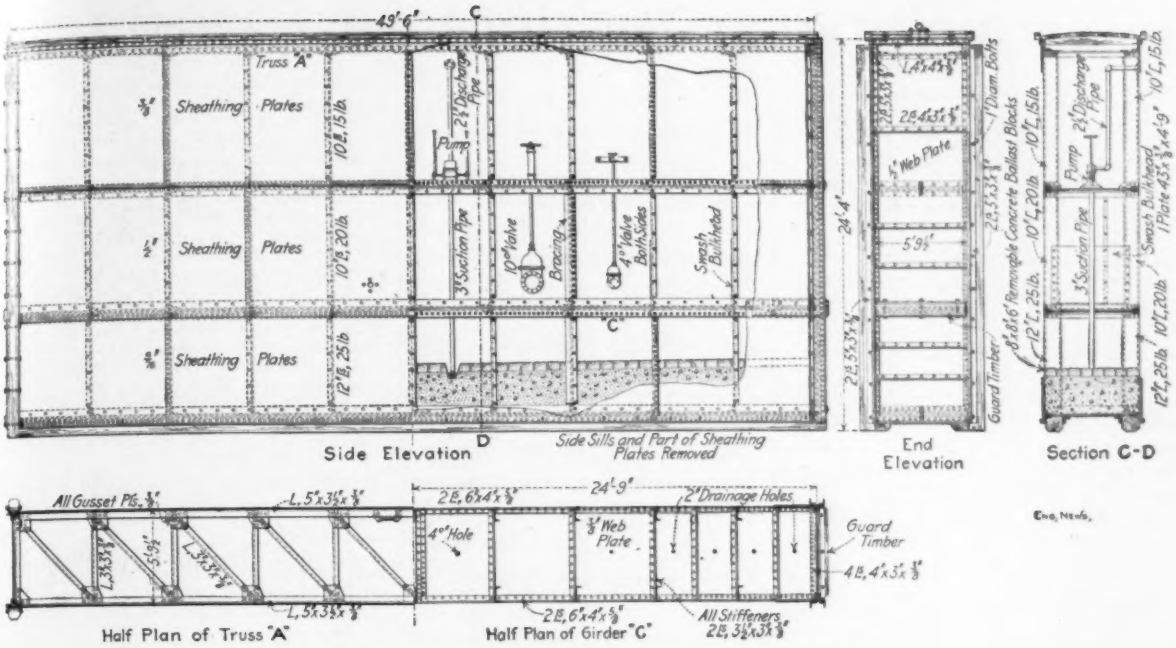


FIG. 2. DETAILS OF THE STEEL CAISSON FINALLY ADOPTED

moving the blocks of concrete which form the top layer of the ballast, after which they will be grouted to prevent further shifting.

There will be no difficulty in painting the caisson as it can be drydocked in one of the locks of the Canal when the lock gates are to be inspected or painted. It will be kept at a prepared anchorage ground, where the depth of water is such that, should sufficient leakage occur to cause it to sink, it will not go deep enough to prevent easy recovery.

The caisson was designed by the writer in connection with the spillways for the Panama Canal, under the general direction of Lieut.-Col. H. F. Hodges, Corps of Engineers, U. S. Army, Assistant Chief Engineer and Member, Isthmian Canal Commission. A contract has been made for two of them and both will be assembled at Gatun. One of them, however, is intended for use at the Miraflores Spillway and it will be towed through the Canal and ordinarily kept in Miraflores Lake.

Remedying Offensive Odors at the Maidstone Sewage Works, England

One of the chief difficulties experienced at some sewage-purification works is the development of offensive odors. This is particularly true, at least in England, where a combination of strong domestic sewage and waste from breweries or tanneries is run through septic tanks. Such a sewage as has just been mentioned is treated in closed septic tanks and on percolating filters at Maidstone, England.

In 1909, Dr. W. J. Howarth, county medical officer of health, reported that there had been excessive odors from the Maidstone sewage works, which treat about 1,200,000 U. S. gal. of sewage per day. Aside from the odors, the chief complaint against the effluent, which is discharged into tidal waters, was that at times it contained an undue amount of harmless solids washed out from the percolating filters. It was only necessary, therefore, to direct attention to the prevention of offensive odors.

The difficulty with odors having been referred to Dr. Turner, he concluded that the odors could be reduced to a minimum by using only one instead of all four of the septic tanks. He also concluded that the efficiency of the percolating filters would not be affected by reducing the septic tank treatment.

According to a recent report by Dr. Howarth, an examination of the septic tank in use on Oct. 18, showed an upper crust of solids sufficiently thick to prevent any escape of the gases generated by septic action, with the result that there was an increased liberation of these foul-smelling gases when the tank liquor was distributed over the filters.

With the substitution of the fresh septic tank for the one previously in use the offensive odors disappeared. Dr. Howarth remarks that the utility of the Maidstone septic tank is crippled by the fact that there is no means of emptying the fluid contents into the outlet sewer coming to the works. The contents can be discharged only upon land, and as each tank has a capacity of 420,000 U. S. gal., a long time may sometimes elapse before one of the tanks can be completely emptied upon land available in the low-lying situation of the Maidstone sewage works.

Attempts at ventilating the Maidstone septic tanks by means of a special lamp for drawing out and burning the gases was not a success. Dr. Howarth states that in the colder months, when there was considerable movement of the air, the sailcloth ventilator had acted in a fairly satisfactory manner, but in the summer months, when there is practically no wind, no ventilation of the tanks was affected.

Dr. Howarth expresses the opinion in his report that with proper supervision of the Maidstone works they can be operated without offense by "(1) sludging the tanks at the proper time; (2) cleaning the tanks when such is necessary; and (3) maintaining adequate ventilation of the tanks."

Track Elevation in Indianapolis is to be extended westward from Senate Ave. to Delaware St., and this will be a work of some difficulty, as it includes the union station and its approaches. This will make it necessary to reconstruct the trainshed and carry out extensive changes to the station building. It may be decided to build an entirely new station, and at the same time improvements will be made in the track layout, which at present requires certain trains to run past the station and then back into the trainshed. A somewhat similar track elevation problem exists at Milwaukee, Wis., where the changes on the Chicago, Milwaukee & St. Paul Ry. will have to be carried through the present union station.

Instructions to Bidders on Contracts

By Jerome Cochran *

A frequent source of trouble in securing comparable bids for work or materials arises from omissions in the general instructions accompanying specifications. The author here presents a standard for checking up the completeness of such general clauses. These suggestions show the ground which is to be covered rather than the precise arrangement and wording which must be modified by local conditions.

*Designing Engineer, Trussed Concrete Steel Co., Detroit, Mich.

This article may be considered, in a measure, a continuation of the writer's article on the "Requirements and Theory of the Advertisement or Notice to Bidders on Contracts for Public Works," published in ENGINEERING NEWS, Sept. 14, 1911.

REPEATING ITEMS FROM ADVERTISEMENT FOR BIDDERS—Even though the printed specifications be preceded by a "Notice to Bidders" stating the place and time of receiving bids, the amount of the check to be deposited with each bid and the bond required, and specifying that the bidder shall give references and shall state work of a similar character he has performed, etc., these items should be repeated in the "Instructions to Bidders." If, necessary, they should be elaborated in order to make clear the conditions under which bids are to be submitted for consideration.

ERRORS OF OMISSION—Errors of omission are so common in the general instructions to bidders accompanying specifications as to make imperative some means of carefully checking the written instructions to bidders before publication, if the author would make sure of their completeness and sufficiency. The errors that occur most frequently are omissions of one or more general instructions. By general instructions are meant those instructions that may be used without material change as a part of any specification for any architectural or engineering work.

SCOPE AND PURPOSE—The general instructions to bidders must not be confused with the general conditions which also accompany specifications and which relate to and describe the work itself. These instructions may in one sense of the word be considered as the advertisement or notice to bidders, but containing more fully the necessary information required by bidders. Quite often, many of these general-instruction clauses for bidders appear in the advertisement for proposals. This practice makes advertising very expensive, and in order to save expense, the advertisement should be as short as possible to contain the necessary information, leaving the general instructions to bidders to be sent out separately, as is generally done in government contracts, and to some extent in city work.

GROUPING INSTRUCTION CLAUSES—It is true that the general instructions to bidders are not always separated and grouped by themselves in the specifications or accompanying them as are generally found. This failure to segregate the general instructions to bidders appears to the writer to be a mistake and, in itself, accountable for many omissions. In compiling the different sections in this article, the endeavor has been not only to present a schedule or list of general instructions to bidders that would be tolerably complete, but also to group the instructions under headings which in a general way would indicate the character of the instruction clauses. There is difficulty in satisfactorily grouping any such heterogeneous collection of clauses, and it is also not at all easy to draw the line between single and compound clauses.

In the actual writing of instructions to bidders it is not necessary to assign a separate paragraph to each of the clauses that are listed in the following sections, even if all of them were used; but in order that no important provision may escape unnoticed it is well to number each section as has been done, for the purpose of checking the written instructions to bidders. In writing each general clause, any desirable number of the single clauses may be grouped together. A careful study must be made, for reasons which will suggest themselves, of the surrounding conditions and limitations and the general instructions to bidders must be modified in accordance to the knowledge obtained.

GENERAL INSTRUCTIONS TO BIDDERS

The general instructions to bidders may be arranged in the following order and relate to any or all of the following subjects:

(1) TIME, PLACE AND MANNER OF OPENING BIDS—When and where bidders shall submit proposals, and how they may withdraw them before the time set for the opening of the bids. No bids to be accepted after that time. Invitation to bidders to be present at the opening of the bids.

(2) PRELIMINARY INFORMATION—Invitation to bidders to visit the plant and examine the locality and character of the material to be encountered in order to make their own estimates, taking account of all possible contingencies in relation to the work.

(3) REQUIREMENTS FOR PLANS AND SPECIFICATIONS—Personal application and return of deposit for plans and specifications. No deposit to be returned unless a proposal is made.

(4) QUALIFICATIONS REQUIRED OF BIDDERS—Bidders must be qualified and have ample means. Failing contractors to be excluded.

(5) BLANK FORMS TO BE USED IN PREPARING BIDS—How the blank forms shall be filled. Blank forms furnished must be used.

(6) FORMALITIES TO BE OBSERVED IN PREPARING PROPOSALS—How proposals are to be made, whether in duplicate or triplicate. Indorsement. Alterations must be explained. Bids to be complete.

(7) ESTIMATE OF QUANTITIES TO BE USED IN COMPARING BIDS—Inclusive prices. Errors and omissions. Quantities may be increased or diminished.

(8) COLLUSION OR OTHER EFFORTS TO PREVENT COMPETITION—All persons interested must be named. Straw bids.

(9) PROPER SIGNATURE OF THE BIDDERS—Bids by individuals, corporations and agents.

(10) INFORMAL BIDS OR PROPOSALS—Proposal must be regular. Provisos attached to proposals.

(11) PROPOSAL BOND OR CERTIFIED CHECK TO ACCOMPANY BID—Statement of the amount and character of guaranty required to accompany the proposal. If a certified check, to whom it shall be made payable. When and where certified checks, except that of the successful bidder, shall be returned. Withdrawal of surety.

(12) GUARANTY OR BOND TO SECURE PERFORMANCE OF THE CONTRACT—Term given to the successful bidder to enter into contract after award. Amount of security. Qualifications of sureties. Names, consent and oath of sureties. Withdrawals of bond or surety.

(13) THE AWARD OF THE CONTRACT—Notification of award. Award to the lowest or any other bidder.

(14) REJECTION AND MODIFICATION OF BIDS RESERVED—Reservation to reject any or all bids. Modification of unit prices bid reserved.

(15) EXECUTION OF THE FORMAL CONTRACT—Time in which to execute the contract. Form of contract. Transfer of contract or part thereof prohibited.

(16) CONDITIONS AND STIPULATIONS AS TO THE PERFORMANCE OF THE WORK—Inspection and acceptance of materials and workmanship. Kind of labor to be employed. Provision that the contractor will not take advantage of any error or omission in the plans or specifications.

(17) CONDITIONS AND STIPULATIONS AS TO THE COMPLETION OF THE WORK—Time for completion of the work to be stated in the bid; this is an important factor in the awarding of the contract. Liquidated damages. Bonus for early completion.

(18) ESTIMATES OF WORK DONE

AND PAYMENTS TO BE MADE—Provision for periodical estimates and payments, whether they shall be monthly or for a shorter or longer period. Deferred payments.

(19) GUARANTEES REQUIRED TO ACCOMPANY BIDS—Annual maintenance, repairing, etc.

(20) SAMPLES TO BE SUBMITTED WITH BIDS—What samples are to indicate. Manner of submitting samples.

(21) RECEPTION OF COMPETITIVE DESIGNS—Arrangement of drawings. Points to be considered in award. Return of rejected plans.

(22) MISCELLANEOUS ITEMS—Schedule and list of unit prices. Special devices.

(1) TIME, PLACE AND MANNER OF OPENING OF BIDS

DATE AND PLACE OF OPENING OF BIDS—Sealed bids or proposals will be received at the office of.....of the City of....., until the..... day of ....., 191.., at 12 o'clock m., for the construction or erection or for furnishing all the labor, tools, appliances, etc., and materials necessary to build, to erect, and to do all the....., and to complete a certain.....(name of structure or work).....at or on..... (name of way or stream)..... in the Town or City of....., County of ....., State of.....

PROPOSAL MUST BE RECEIVED ON TIME—Bids to be considered must be in at the above specified time. Any or all bids received after the hour named (or fixed) for delivering the proposals will not be opened or considered unless all of the bids then presented shall have been rejected and reconsidered.

PUBLIC OPENING OF BIDS—Upon receipt of the bids or proposals at the time and place specified, the board of public works will immediately proceed to unseal the same and publicly announce the contents in the presence of the parties bidding or their agents, and also to make proper record of the prices and terms upon the minutes of the board. Bidders or their representatives are invited to be present at the opening of bids. The public should also have the right to inspect bids at the opening.

RETURN OF BIDS AFTER DATE NAMED—All proposals received after the time stated for opening will be returned to the bidders unopened. Bidders are, therefore, requested to allow ample time for the transmission of their bids by mail.

(2) PRELIMINARY INFORMATION

OBTAINING INFORMATION — Plans and detailed specifications may be seen, and proposal blanks, form of contract and bond required and other information for bidders may be obtained at the office of the superintendent of public works, and also at the office of the engineer. Supplementary drawings exhibiting geological formation, so far as has been determined by borings, and records of certain experimental work, which may afford data to the contractor, can be seen in the engineer's office.

VERBAL EXPLANATION—The engineer will not give verbal answers to inquiries regarding the meaning or intent of the drawings and specifications previous to the award of the contract.

REQUEST FOR INFORMATION—Any information desired by a bidder must be requested in writing. If reply is made, such questions and reply will be communicated to all bidders. That is to say, should any bidder be in doubt as to the intention and meaning of the drawings and specifications, he is to make written inquiry as to such points of the engineer, from whom he will receive a written answer, and the inquiry and answer will be posted in the engineer's office, or sent to all bidders.

LOCAL CONDITIONS—Bidders, or their authorized agents, are expected (generally they are required) to examine the maps and drawings in the engineer's office, which are open to their inspection, to visit the locality of the work, and to make their own estimates of the facilities and difficulties attending the execution of the proposed contract, including local conditions, uncertainty of weather, and all other contingencies. That is to say, each bidder, or at least one of a contracting firm or their or its engineer, shall visit the site of the works and make himself acquainted with the character of the ground, facilities for transportation and all other conditions likely to affect the cost of the proposed works, so that he may make his bid intelligently. Bidders shall not at any time after submission of a bid dispute or complain of errors in estimates, nor assert that there was a misunderstanding in regard to the work to be done or the materials to be furnished.

VERBAL INSTRUCTIONS—Neither the city nor the engineer will be responsible in any manner for verbal answers given to any inquiries regarding the meanings of drawings or specifications, or for any verbal instructions, whether by themselves, their employees or others, prior to award of contract, and bidders for their own protection are hereby notified to demand such answers or instructions in writing.

OMISSIONS FROM PLANS AND SPECIFICATIONS—Should any bidder observe any omission from plans and specifications, he should at once report it to the engineer, as no changes will be allowed after the contract is awarded.

CANVASSING OF BIDS—In canvassing bids, the following factors will be taken into consideration: (1) Cost; (2) ability and responsibility of contractor; (3) time of completion.

(3) REQUIREMENTS FOR PLANS AND SPECIFICATIONS

IN GENERAL—Pamphlets containing (1) instructions to bidders, (2) forms of proposals, (3) specifications, (4) form of contract, and (5) contract drawings, will be furnished on application to the engineer, upon receipt of a deposit of $..... Anyone asking or sending for blank forms, specifications, etc., must give his principal's name and address, otherwise forms and specifications will be refused.

PERSONAL APPLICATION—Bidders will be required to call at the office of the engineer in person, as no plans or specifications will be mailed on application.

DEPOSIT REQUIRED—No attention will be paid to requests for plans and specifications unless accompanied by the required deposit. (It is sometimes customary, although not often, to distribute the plans and specifications for the free use of bidders.)

RETURN OF DEPOSIT—The deposit will be returned to the bidders upon the return of the plans and specifications in good shape within ten days after time of opening bids. (At times the deposit is not returned to the bidder upon the return of his plans and specifications, being retained to cover the actual cost of printing them.)

CERTAIN PERSONS EXCLUDED FROM RECEIVING PLANS, ETC.—No subcontractors, material men, etc., will be furnished with plans or specifications. (They may be seen at any time at the office of the engineer by contractors, subcontractors, material men, etc.) General contractors must arrange to procure such bid or bids from the plans and specifications which they procure by applying to the engineer, and filing with him a certified check for $....., made payable unconditionally to the order of the city council. In other words, only general contractors who figure the work as a whole shall be permitted the use of a complete set of plans throughout the time allotted for figuring.

FAILURE TO RETURN PLANS—Any contractor who fails to return his set of plans within the time granted will necessitate the printing of extra plans by the engineer, and shall forfeit his deposit of $..... to cover the cost of such extra printing.

(4) QUALIFICATIONS REQUIRED OF BIDDERS

IN GENERAL—Proposals from parties who are not known to be regularly and practically engaged in the class of work called for by the plans and specifications will not be accepted. Bidders must be skilled and regularly engaged in the class of work upon which they bid.

CHARACTER OF THE BIDDER—The character of the bidder shall be taken into careful consideration. If his character will not pass for general honesty, uprightness and fairness in his business, his bid shall be thrown out.

COMMERCIAL STANDING—Each bidder is required to give reference as to his business standing. Lack of commercial standing on the part of the bidder will constitute good and sufficient ground for the rejection of his bid. (It cannot be too strongly insisted that bidders give upon their proposals satisfactory references as to their ability to properly finance the work upon which they bid.)

PAST EXPERIENCE—The experience of bidders will largely influence the letting of contracts, and each bidder should be required to make a statement indicating what similar work he has done, and the condition of other structures of a similar character put up by him. Due weight should be given to the past experience of the bidder, and sufficient lack thereof on his part will constitute good and reasonable ground for the rejection of his bid. Intending bidders must state, upon inquiry by the engineer, the name and address of the engineer of the said work.

OATH AS TO THE NECESSARY EQUIPMENT—A statement shall be required of the bidder, under oath, that he has a permanent plant located within a reasonable distance of the place where said work is to be performed, and also that he is fully equipped for the performance of the work, and ready to commence within the specified number of days after the award is made.

DEFAULT IN PAYMENT FOR WORK OR LABOR PERFORMED—No person is eligible as a bidder who has within two years prior to the letting of this contract made default in payment for any work or labor performed, or any skill or material furnished pursuant to any such contract as herein advertised, or who within said two years failed to complete any such contracts.

DEFAULT AS SURETY OR OTHERWISE—No proposals will be accepted from any person or firm who are in arrear to the City of..... upon

debt or contract, or who is in default as surety, or otherwise upon any obligation to the city.

CITIZENSHIP—Each bidder must be a citizen of the United States.

(5) BLANK FORMS TO BE USED IN PREPARING PROPOSALS

FURNISHING BLANK FORMS—It is customary for the engineer or agent letting the work to prepare and furnish to the bidders blank forms, to be filled out by them, with instructions concerning the manner of so doing, time of presentation and opening, and whatever restrictions may be imposed upon parties desiring the work, with any other information deemed necessary.

THE OBJECT OF USING BLANK FORMS—The object of furnishing printed blank forms is to insure that all bidders shall submit their proposals on exactly the same items and estimate prices in the same units, otherwise, there would be no regularity whatever, and it would be difficult to interpret the exact meaning of some of them. So much stress is generaly placed upon bids being submitted upon the blanks furnished, that it is customary to reject all bids not so prepared, as well as bids, which, though made on the printed forms, have changed the conditions of the same in any particular, either in the phraseology of the proposal, addition to the items mentioned therein, or a failure to observe strictly the printed instructions. Alterations by erasure or interlineation on the printed forms have caused their rejections, and the bidder cannot be any too careful in submitting bids. The practice of preparing and supplying printed blank forms of proposals, guaranty to accompany proposal, oath of bondsmen and the formal contract should always be followed in order to make the bids strictly comparable in every respect.

FILLING OUT BLANKS FOR PROPOSALS—The manner of filling out the blanks, endorsing the bids, and formalities to be observed in submitting proposals will be fully set forth in the following sections. If the blanks are not properly filled out, the official to whom the bid is being made may throw out the bid if he cares to do so, although it is generally stated that the right is reserved to waive defects in bids in the interest of the city. The blank forms generally used have spaces in which to write out in words, as well as in figures, the amounts bid for the various items or parts of the work. This is very essential, and should be done in all proposals or contracts whether there is a special place for it or not.

PROPOSALS ON CONTRACTOR'S LETTER-HEADS—For small contracts, where no specal forms for proposals are specified, it is customary to allow proposals to be made out on the letterheads of the contractorl or the party proposing to do the work or furnish the materials. All proposals must be signed by the bidder and may contain any explanation the bidder may wish to make, but should be required to contain the following paragraph:

The undersigned proposes to perform the work, furnish all materials and labor and to execute the finish product shown on the drawings and described in the specifications as prepared by the City Engineer for.....at..... and abide by all conditions as named and set forth.

ORDINARY BLANK FORM OF PROPOSAL—In adopting the following form of proposal the writer has adopted what seems to be a rational subdivision, and one that does not depart materially from established forms in general use.

PROPOSAL—

For .....

(Location) .....

The undersigned hereby propose, and if this proposal is accepted, agree to enter into a written contract, with the .....(City of.....) to supply all labor and material and complete all work according to the plans and directions of the engineer for said ..... (City of.....), in conformity with the specifications attached hereto, upon the terms and conditions of the contract prepared therefor, and within the time specified, as follows:

.....

.....

.....

All of the above work to be completed on or before....., 191..

Accompanying this proposal is a certified check for.....dollars ($.....), which shall become the property of the ..... city (or county or state) of ....., if in case this proposal is accepted by the said.....city (or county or state), or its authorized officers the undersigned shall fail or refuse to execute the contract and furnish a bond, according to the requirements of the instructions to bidders, hereto appended, within the time provided by said notice; otherwise the said check shall be returned to the undersigned within .....days after the date set for opening the bids.

In case this proposal is accepted by the city (or county or state) of..... Messrs.....resident of....., and.....resident of....., are offered as sureties for the faithful execution of the contract.

Signature of Proposer.....
Address.....
Dated....., 191..

BOND FOR EXECUTION OF CONTRACT—The following blank form of bond has been selected as embodying the requirements to be observed in preparing a bond for the execution of a contract.

CONTRACT BOND—

KNOW ALL MEN BY THESE PRESENTS that we.....

.....

.....

of..... (hereafter called the contractor), as principal, and the .....

.....

.....

hereinafter called the surety), as surety, are jointly and severally held and firmly bound unto the City of.....(or county or state) (hereinafter called the obligee) in the sum of.....dollars ($.....), lawful money of the United States of America, for the payment whereof said contractor bind....., heirs, executors, administrators, successors and assigns, and said surety binds itself and its successors and assigns firmly by these presents.

WHEREAS, the said contractor has made a proposal to the City of..... (or county or state), ...bearing date the.....day of....., 191.., and annexed hereto;

AND WHEREAS, the surety has read the contract and specifications and agrees to be bound by all the stipulations therein in respect to them;

NOW, THEREFOPE, the condition of this obligation is such that if the said contractor shall well and truly keep and perform all the items and conditions of the said contract on his part to be kept and performed, both concerning the work immediately contemplated and of any extensions and alterations thereof (of which extensions and alterations said surety hereby waive notice) and agree that all the provisions of this obligation shall apply to said contract as it may from time to time be extended and altered, either by the engineer under any of the provisions therein contained or by the parties thereto, in the same manner as if such extensions and alterations were actually inserted therein; that may be ordered by the said City of ..... (or county or state); and shall indemnify and save harmless the said city (or county or state) from all suits or actions of any name or description brought against the said contractor, or the said city, county or state for or on account of any injuries or damages received or sustained by any person or persons by or from the said contractor, his servants or agents, in the construction of said work, or by or in consequence of any neglect in guarding the same, or any improper materials used in its construction, or by or on account of any act or omission of said contractor, his servants or agents, in or about the premises, then this obligation shall be void; otherwise to remain in full force and virtue.

.....(seal).
.....(seal).

Witnesses:

.....
.....

Dated....., 191..

(To be executed in duplicate or triplicate.)

(6) FORMALITIES TO BE OBSERVED IN PREPARING PROPOSALS

SUBMISSION OF PROPOSALS—The attention of the bidders should be called to the specifications and form of contract under which the work is to be done, and also to the observance of the following formalities: Proposals to receive consideration must be made in accordance with the following instructions, and parties making bids for the work contemplated under the specifications must familiarize themselves therewith.

ADVERTISEMENT—Should the city publicly advertise the letting of any contract, the details of the advertisement must be carefully observed by the bidder in presenting his bid and a copy of the advertisement or notice to bidders must be attached to bidding sheet or proposal.

BLANK FORMS—Proposals must be made upon the blank form accompanying the instructions to bidders, and all blanks in the form must be fully filled in; those for numbers must be filled both in writing and in figures, and the completed form must be without interlination, alteration, or erasure. (See Section 5, above.)

ADDRESSED AND INDORSED—All proposals must be properly addressed to the engineer, or to the party letting the contract, and indorsed "Proposals for the Construction (or Building of)....." Envelopes containing proposals must be plainly marked on the outside as to contents. Proposals must be inclosed in sealed envelops, indorsed as above and placed in a second envelope addressed to "Engineer, Board of Public Works, etc." Printed envelopes are sometimes furnished the bidder. It would be well if they were furnished at all times.

DELIVERY OF PROPOSALS—Proposals must be delivered not later than the

hour named on the form of proposal. All bids must be self-explanatory. No opportunity should be offered for oral explanation, except as the party of the first part desires fuller explanation of particular or peculiar devices.

EXPERIENCE OF BIDDER—Bidders must state at the proper place on the proposal the length of time they have been engaged at contracting, and the places where they have done and carried to satisfactory conclusion contracts involving work of the kind upon which they are bidding. (See Section 4.)

LOCAL CONDITIONS—Bidders must get their information as to local condition of trade, labor, character of soil, probable amount of water, rock, etc., from personal inquiry on the ground. (See Section 2.)

REGULATIONS GOVERNING TENDERING—The usual conditions relating to tendering as prescribed by city (or county or state) ordinance must be strictly complied with or the tenders will not be accepted. Bidders must have paid their city license (if such be required) in order that their bids may be accepted. All bids received from contractors who have failed unjustifiably to fill former contracts with the city will be rejected.

UNION SCALE OF WAGES—All proposals submitted must be based upon the union scale of wages and the eight-hour working day for all workmen employed on works.

SEPARATE AND ALTERNATE BIDS—Many separate and alternate bids are generally asked for, and the bidders are advised to carefully note the order and scope of same before beginning to take off the quantities, and to carefully schedule their work so as to be able to present an accurate and clearly defined proposition.

COMBINATION OF BIDS—Bids may be made for any department of any one building; for any department covering all buildings; for any one or more buildings as a whole, or lump bid; or for all buildings as a whole, or lump bid.

CONSTRUING BIDS—If a bid is made upon more than one branch of work, it will be considered as a series of separate bids upon each of the branches for which a figure is given, unless the bidder states plainly in the bid that he intends it as a lump or combination bid upon all branches included in said bid. Generally, however, it is customary to state that each bid shall be construed to cover all the work specified of the class bid for, notwithstanding the bidder in recapitulating the same may omit some parts.

DOCUMENTS COMPOSING THE PROPOSAL—One copy each of the advertisement, the instructions for bidders, and the specifications, must be securely attached to the proposal and be considered as comprising a part of it.

FORMS MUST BE KEPT INTACT—No bid will be received if detached from the other forms with which it is bound; the entire package must be delivered unbroken and in good order, complete in all respects.

RETURN OF PLANS AND SPECIFICATIONS—All drawings and specifications must be returned to the engineer with the proposals, as no bid will be considered unless drawings and specifications are returned. Sometimes it is customary to allow a certain time within which the plans and specifications are to be returned before the opening of bids.

BIDDERS AGREE TO FORMS FURNISHED—Parties making bids are understood to accept the terms and conditions contained and expressed in the forms of contract, specifications, plans, etc., annexed to the proposal submitted. That is to say, all proposals shall be made and received with the express understanding that the bidder accepts the terms and conditions contained in the general instructions and specifications, form of contract and bond.

CARE OF DRAWINGS AND SPECIFICATIONS—Bidders are required to return drawings and specifications without marks, notes, or mutilations thereon.

ALTERATIONS MUST BE EXPLAINED—Alterations by erasure or interlineation must be explained or noted in the proposal over the signature of the bidder. That is to say, any alterations or erasures must be explained or noted in the margin opposite, and be attested by the signature of the bidder.

PROPOSAL MUST BE REGULAR—All blank spaces in the proposal and bond must be filled in, and no change shall be made in the phraseology of the proposal, or addition to the items mentioned therein.

MODIFICATIONS OF PLANS—Bidders are sometimes allowed to indicate at the time they present their bids, but in separate statements (or sheets), modifications of details which they may consider expedient to make in the proposed improvement as planned, as well as in the manner of executing same. In that case they must accompany their tender with a statement justifying these modifications and the methods of executing them, which they propose to adopt. Eventually they will be required to submit their explanatory calculations with reference to their modifications. That is to say, in case the bidder's proposal varies in any manner from the accompanying specifications, attention should be called to the points of difference in the said proposal.

PROPRIETARY ARTICLES—Contractors are generally at liberty to bid on articles of equal value in place of any proprietary article mentioned in the specifications, or shown on the drawings, subject, however, to the approval of the engineer. When a change is suggested the difference in price must always be stated in the proposal. If the change is accepted, it shall be so noted in writing on the specifications attached thereto. After the signing of the contract, no changes should be allowed in the specifications.

PATENT RIGHTS—Each bidder must understand that he is to protect and indemnify all persons acting for and in behalf of the city (or county or state) for any liability which may be claimed by any party on account of any patent rights connected with any of the materials, articles, or processes used or employed in the work or in its performance, or any contemplated or embraced in his proposal.

LICENSE AGREEMENT TO BE FURNISHED—License agreement must be filed with the engineer at least ten days prior to the letting by those controling patents of any material set forth in the specifications, agreeing to furnish the materials to any bidder at a fixed price, and bids will not be considered on the materials for which no price has been filed.

MODIFICATIONS—No verbal, telegraphic or telephonic modifications of proposals will be considered, as the city (or county or state) will in nowise be responsible or make any allowance for errors, oversights or misjudgments of the bidder.

PROPOSALS SENT BY REGISTERED MAIL—All proposals sent by mail should be sent special delivery or registered. If proposal is sent by mail, allowance should be made for the additional time required for such transmission.

BIDS NOT TO BE WITHDRAWN NOR CHANGED—Permission will not be given to withdraw, modify or explain any proposal or bid after it has been deposited with the engineer; therefore, the bidder is cautioned to properly check his proposal, and to see that all copies of his proposal agree in all particulars. A violation of this provision on the part of the bidder shall forfeit to the city (or county or state) his deposit as liquidated damages for his breach of contract.

BIDS MAY BE WITHDRAWN (Alternate Clause)—If a bidder wishes to withdraw his proposal he may do so before the time fixed for the opening without prejudice to himself by communicating his purpose in writing or by telegraph to the engineer, and when reached, it shall be handed to him or his authorized agent, unread. Communications requesting withdrawal of bids shall reach the engineer not later than one hour before the time fixed for the opening of the bids. No proposal can be withdrawn after the time for receiving bids has expired.

SAMPLES—No proposal will be received or considered unless there shall be attached to the outside of the envelope containing the proposal the engineer's receipt for samples filed in strict accordance with the requirements of the specifications. (See Section 20.)

BIDS MUST BE COMPLETE—Bids must be made out for completed work as per schedule and no partial bids will be considered.

ALTERNATE BIDS—It is sometimes customary to state that parties who do not desire to bid upon the specifications adopted by the city council (or proper county or state body) may submit alternative bids.

FOREIGN CORPORATIONS—The following clause was used in asking for bids on public work for Steelton, Penn.:

Foreign corporations desiring to make bids should be registered in the office of the secretary of the commonwealth as required by the act of April 22, 1874, and have a bona fide resident agent in this state with a fixed office, and as a further protection to the borough of Steelton the successful bidder, if a foreign corporation, may, at the option of the town council, be required to empower some person or company satisfactory to the town council to accept service for such successful bidders during the term of contract and bond.

PRICES—All prices in proposals must be written as well as expressed in figures, but written prices shall control where they differ from the figures. Bidders are not to state any price for material and work for which there is a fixed amount provided for with the specifications. The prices must be stated in the respective columns provided for same, and must be so distinctly expressed that there can be no doubt as to the meaning of the same. Illegible figures will invalidate the bid. The price bid must include everything as described in the specification under each item.

NAMES OF SUB-BIDDERS—The contractor shall in all cases name sub-bidders with whom he is figuring, and they must receive the approval of the engineer.

NAMES OF BONDSMEN—Each bidder will state in his proposal the names and

addresses of his bondsmen. (See Section 12.)

INFORMAL REQUEST—It is sometimes customary to request bidders to state at what price they will furnish and install an additional article of the same or a similar make as bid upon. However, it must be remembered that this is an informal request, and must not be mentioned or referred to in the formal bid, nor inclosed with the proposal proper.

FORMALITIES MUST BE OBSERVED—No bids will be received unless all of the requirements are complied with on the part of the bidder. That is to say, only such proposals will be considered as are complete, in proper form, comply with the requirements herein stated, and are offered by parties of known reputation, experience and responsibility. In other words, the bidder must comply strictly with all the conditions named in the instructions to bidders, specifications and the drawings to which they refer.

(7) ESTIMATE OF QUANTITIES TO BE USED IN COMPARING BIDS

IN GENERAL—All bids will be compared on the basis of the engineer's estimate of quantities of work to be done, which is as follows:

Item (a), 64,820 sq.yd. creosoted wood blocks.

Item (b), 23,000 cu.yd. of earth excavation.

Item (c), 11,125 cu.yd. concrete foundation, etc.

ESTIMATE IS APPROXIMATE—The engineer's estimate of quantities is that by which all bids will be compared. These quantities are to be regarded as merely approximate, and are given only as a basis for comparing the bids.

BIDDER'S RESPONSIBILITY—It must be understood that neither the city (or county or state) or its engineer will be responsible for the accuracy of the above quantities, and if the contractor makes use of them in preparing his bid he must do so at his own risk, as he will not be entitled to make any claim or demand, nor raise any question whatsoever, on account of any errors or miscalculations in or misunderstanding of the said quantities, they being given for the convenience of the city (or county or state) and its engineer. Where the engineer has listed any of the work, the contractor should check up the same, and see that all material called for by the drawings is complete in his estimate.

PERSONAL EXAMINATION—The above mentioned quantities, though stated with as much accuracy as is possible in advance, are approximate only, and each bidder will be required to secure accurate information concerning the above quantities by personal examination of the location of the proposed works, and by a careful examination of the drawings and specifications, for should his proposal be accepted he will be responsible for any and every error in his proposal resulting from his failure to do so.

ESTIMATE IS CORRECT (Alternate Clause)—The quantities enumerated in 'ated in the form of proposal are in the form of proposal are intended to be, and can be considered, the actual quantities that will be required.

EXTRA WORK—For all other items not covered in the above list of quantities the contractor is to be paid the actual cost to him there of plus ten (10) per cent. for his profit.

BID IS FOR WHOLE WORK—In the form of proposal the materials to be furnished and the work to be done are itemized for the purpose of comparing the bids and as a basis for the monthly estimates, but if the contract be awarded it will be as a whole. It is customary, unless otherwise stated, that each proposal shall cover the entire work.

COMPARISON OF BIDS—Bidders should be requested to extend the price of each item and foot up total in column provided, in order that a comparison of bids may be readily made.

UNIT PRICE BID—No proposal will be considered that does not contain a unit price bid on each and every item stipulated in the proposal blank. Where unit prices are given for additions the same unit price shall be used for deductions and omissions. Where the work bid for embraces both labor and material, they must be separately stated with the prices thereof given in both words and figures. Each bid for each item must include the performance of all the work and the furnishing of all the material, in accordance with the general contract and the specifications for the work and material included under the 'tem on which a bid is submitted.

INCLUSIVE PRICES—The prices given in the proposal shall include the supply and erection in a good, sound, substantial and workmanlike manner of all items required for the completion of the whole work proposed for, and shall include all items shown on the drawings and described in the specifications; also, all forms, centering, falseworks, tramways, machinery, scaffolding, labor, workmanship, tools and materials necessary and best adapted to the efficient, prompt and safe execution of both the permanent and temporary works.

PARTIAL BIDS—Bidders must state the proposal price for each separate item of the work called for in the proposal blank, and if the price is omitted, the blank may be filled with the highest price named by any bidder for that item or the proposal may be rejected.

ERRORS AND OMISSIONS—No allowance shall be claimed by or made to the contractor whose bid may be accepted for any error, of whatsoever description, that may be discovered after his bid is sent in, and in any such case payments on the actual quantity supplied will be made only in proportion to the total lump sum tendered. In other words, no allowance will be made for the failure of a bidder or a contractor to estimate correctly the difficulties attending the execution of the work.

QUANTITIES MAY BE INCREASED OR DIMINISHED—It must be understood that the estimate of quantities given in the instructions to bidders are to serve as a basis for comparison of bids, and the right should be expressly reserved to increase or diminish the quantities or altogether omit any items that in the judgment of the engineer may be deemed unnecessary.

CLAIMS FOR DAMAGES OR EXTRA WORK—Such additions or omissions do not entitle the contractor to any claim for extra work in the completion of the work, or to any other claims for damages, if the quantities of work and materials should prove to be greater or less than estimated. In other words, the said quantities being approximate, and subject to modification, shall not control or determine the final estimate of the work, which shall be made from measurements of the actual work performed and materials furnished. No extras of any kind will be allowed unless ordered, in writing, by the engineer, and indorsed by the city council (or proper county or state body).

LIMIT OF INCREASE OR DECREASE OF QUANTITIES—The right is generally reserved to increase or diminish the quantity of any item or all items, by an amount not exceeding twenty (20) per cent. of the quantity or quantities designated in the proposal sheet.

UNBALANCED BID—No bid will be accepted which does not retain an adequate or reasonable price for each and every item named in the schedule of prices. In other words, any bid in which the prices stated for the several items are unbalanced shall be immediately rejected. (See Section 10.)

(8) COLLUSION OR OTHER EFFORTS TO PREVENT COMPETITION

NO ASSISTANCE WHATEVER—Proposals must be prepared without the assistance, additional information, or suggestion of any person belonging to, employed by, or holding office in the city (or county or state). The superintendent, inspector, clerk or employees or other persons in any manner connected with the office of the engineer, shall not be interested, either directly or indirectly in the contract or be entitled to any benefit derived therefrom; and any violation of this understanding shall work a forfeiture of all moneys which may become due to the successful bidder.

GOVERNMENT OFFICERS CAN HAVE NO INTEREST—In work for the Federal Government the following clause is often inserted in the general instructions to bidders:

> No member of or delegate to congress, nor any person belonging to or employed in the ..... service of the United States, shall have any interest in the contract for this work or any benefit that may arise therefrom; but if the contract be made with an incorporate company for its general benefit, this rule will not be construed to extend to this contract so far as it relates to members of congress.

OTHER BIDDERS—No bidder should be informed, directly or indirectly, of the name of any person intending to bid or not to bid, or to whom information in respect to proposals may have been given. The reason is obvious.

BID TO BE FAIR IN ALL RESPECTS—The proposal should state that it is made without any connection with any other person making an estimate for the same purpose, and is in all respects fair and without collusion or fraud, and that no member of the board of aldermen, head of a department, chief of a bureau, deputy thereof, or clerk therein, or other officer of the corporation is, shall be or become interested therein directly or indirectly, as contracting party, partner, or in the performance of the contract, or in the supplies, work or business to which it relates, or in any portion of the profits thereof, accruing from or by virtue of the letting.

AFFIDAVIT—Bids should be accompanied with an affidavit that the bidders have not entered into any combination, collusion or agreement whatsoever, to maintain the price of bids, or prevent others from bidding. Blank affidavits may generally be had upon application to the engineer. The following form is suggested:

> Affiant....., whose bid is attached hereto, states on oath that he is not entered into any conspiracy, combination or arrangement of any kind whatsoever, to prevent or dissuade, directly or indirectly, any person, firm or corporation from bidding at this letting.

NO INTEREST IN OTHER BIDS—Reasonable grounds for supposing that any bidder is interested in more than

one proposal for the same item may cause the rejection of all proposals in which he is interested. The proposal should be required to state that the bidder has not directly or indirectly induced or solicited any bidder to put in a sham bid.

STRAW BIDS—Two proposals from one firm or association under different names will not be considered.

(9) PROPER SIGNATURE OF THE BIDDER

IN GENERAL—No bid should be entertained which is not properly signed by the bidder, i.e., subscribed by the genuine signature of the bidder.

INDIVIDUAL SIGNATURE—A proposal by a person who affixes to his signature the word "president," "secretary," "agent," or other designation, without disclosing his principal, is the proposal of an individual.

BIDDER'S RESIDENCE AND ADDRESS—The place of residence of each bidder, with post-office address, county and state, district or territory, must be given after his signature, which must be written in full.

SIGNATURES AND SEALS—All signatures should be witnessed and have affixed to them seals of wax or wafer.

SIGNATURES OF FIRMS—When a firm bids, the individual names of the members should be written out, and should be signed in full, giving the Christian names; but the signers may, if they choose, describe themselves, in addition, as doing business under a given name and style as a firm. That is to say, proposals by a firm should be signed by the firm name, either by a member thereof or by its agent, giving the names of all the members of the firm in full.

BIDS BY CORPORATIONS—In cases where a corporation submits a proposal, the proposal must be signed with the name of the corporation, and the full name of each officer of the corporation, and their addresses given, with official corporate seal attached thereto. In other words, proposals by a corporation should be signed with the name of the corporation followed by the signature of the "president," "secretary," or other person authorized to bind it in the matter. If possible, the seal of the corporation should always be affixed.

BIDS BY AGENTS—Anyone signing a proposal as the agent of another or of others must file with it legal evidence of his authority to do so.

OFFICER'S AUTHORITY TO BID—If a person signs for a corporation he must present legal evidence that he has rightful authority to such signature, that the signature is binding upon the corporation, and that the corporation has a legal existence.

CITY OFFICIAL—No proposal should be entertained which contains the signature of a city (or county or state) official, either as principal or surety.

(10) INFORMAL BIDS OR PROPOSALS

IN GENERAL—No bid should be entertained which is not based upon the plans and the accompanying specifications, or which contains any erasures or written memorandum qualifying the same, or is not properly made out and signed by the bidder. Bidders should be advised that any and all bids deficient in any of the following requirements may be rejected as informal.

PROPOSAL MUST BE REGULAR—Proposals that contain any omission, erasures, alterations, additions or items not called for in the specifications, plans, bill of quantities contained in the blank form of proposal, or that contain irregularities of any kind, may be rejected as informal. That is to say, any conditions, limitations or provisos attached to a proposal will be liable to render it informal, and may cause its rejection. Bids must be in conformity with the notice or instructions to bidders.

ILLEGIBILITY AND AMBIGUITY—Illegibility, or ambiguity, will invalidate a bid. The writing must be clear and distinct, so that no question can arise as to its intent and meaning.

UNBALANCED BID NOT ACCEPTABLE—Bids must be balanced, no prices being unreasonably low or high. Any bid in which the prices stated for the several items are unbalanced may be rejected. It is assumed that every bid is made in the interest of the bidder, and that he expects to make a fair profit on the work. If, therefore, items of any bid are manifestly below their actual and necessary cost, it will be attributed either to the ignorance of the bidder or a design to gain some unfair advantage, and such bids should be immediately rejected as being informal.

DOLLARS BID IN THE CENTS COLUMN—Bidders are cautioned against placing a dollar bid in the cents column, or a cents bid in the dollars column, for any error of this character, no matter how obviously it may be an error, may cause the rejection of the whole bid as being informal.

BID NOT TO BE DETACHED—No bid should be received if detached from the package in which it is bound; nor should any of the accompanying papers be detached therefrom; but the entire package must be complete and in good order when the bid is deposited.

AFFIDAVIT—Any bid not accompanied by an affidavit to the effect that the bid is genuine and not sham or collusive, or in violation thereof, should be considered informal or irregular and should be rejected.

ORDINANCES GOVERNING CITY BIDS—All bids must be made in accordance with ordinances governing same or they should be rejected.

CERTIFIED CHECK—No bid should be considered unless accompanied by the required certified check. (See Section 11.)

DIFFERENT BIDS FROM THE SAME FIRM—Bids submitted by different members of the same firm or copartnership should not be considered.

PARTIES IN DEFAULT—Bids will be considered informal from any party or parties in default or who may have defaulted upon any contract with the city.

NATURE AND EXTENT OF WORK—No bid will be received in case the bidder has not looked the work over on the grounds. (See Section 2.)

(11) PROPOSAL BOND OR CERTIFIED CHECK TO ACCOMPANY BID

IN GENERAL—Each bidder must submit with his proposal a money deposit in the form of a draft or certified check upon some good banking institution in the City of....., issued by a national or state bank in good credit within the state, and payable at sight to the order of..... for (say) five (5) per cent. of the total amount of the bid tendered. The check shall contain no conditions either in the body or indorsements thereof.

DELIVERY OF CERTIFIED CHECKS—Certified checks are to be inclosed in separate envelopes, as each check will be examined before the accompanying proposal is opened. In other words, such check or money is not to be inclosed in the sealed envelope containing the estimate or proposal, but it is to be delivered to the engineer or parties letting the contract in another sealed envelope and properly addressed, but otherwise unmarked. No proposal should be received until such check or money has been deposited and examined and found to be correct. The certified check may also be submitted personally upon the presentation of the bid.

CASHING CHECK PRIOR TO ACCEPTING BIDS—The city (or county or state) treasurer shall have the right to send the check of any bidder or bidders likely to be awarded the work, for collection prior to the acceptance of the bid. Cash to be held until the contract is signed or proposal rejected.

REFUSAL TO EXECUTE CONTRACT—Should the successful bidder fail or refuse to execute a formal bond or contract within ten days after the same is sent him, his certified check may be declared forfeited, the letter of acceptance of his proposal may be revoked, and all obligations in connection therewith will be released and annulled. In other words, the deposit of the successful bidder will be forfeited to the city (or county, etc.) in the event of the failure of the bidder to sign the contract and furnish the necessary bond or bonds within ten days after the contract is presented to him for his signature.

RETURN OF CERTIFIED CHECKS—All deposits except that of the successful bidder should be returned to the persons making the same within five days after the contract is awarded. The deposit of the successful bidder may be returned with the first monthly payment. The obligation of bidders should cease and their checks returned not later than two weeks after the opening of bids. Should all bids be rejected all checks should be returned at once.

WITHDRAWAL OF SURETY—Neither the principal nor sureties on any bid should have the right to withdraw or cancel the same until the city council shall have let the contract for which such bid is made, and the same shall have been duly executed.

(12) GUARANTY OR BOND TO SECURE PERFORMANCE OF THE CONTRACT

IN GENERAL—A bond for the faithful and complete performance of the contract should be required of the person to whom the same may be awarded. The surety required to guarantee the faithful performance of the work should be one or more bonds executed by one or more guarantee or surety companies aggregating in amount at least fifty (50) per cent. of the amount of the contract.

BOND FOR EXECUTION OF CONTRACT (U. S. Form)—The following clause is taken from among those given in the instructions to bidders for a certain contract for the United States Government:

> The bond attached to each copy of the bid must be signed by an authorized surety company, or by two responsible guarantors, to be certified to as good and sufficient guarantors by a judge or clerk of a United States court, a United States district attorney, United States commissioner, collector of customs, judge or clerk of a state court of record, or by some other officer under the United States Government. The seal of said court must be attached. Each guarantor must justify in a sum not less than one-tenth of the whole amount of the proposal.

CONSENT OF SURETIES—Each bidder should be required to furnish with

his proposal a statement from a surety company, stating that it will sign his bond in case the contract be awarded to him. The bid may also be accompanied by the consent in writing of two householders within the state, with their respective places of business or residence, to the effect that if the contract be awarded to the bidder they will, upon its being so awarded, become bound as his sureties for its faithful performance.

OATH OF SURETIES—The consent of sureties should be accompanied by the oath or affirmation in writing of each of the persons signing the bond or bonds that he is a householder or freeholder in the state where the proposed work is to be executed, and is the owner of property in value equal to the amount of the surety required for the faithful completion of the contract as stated in the proposal, over and above all his debts of every nature, and over and above his liabilities as bail, surety or otherwise. In other words, the proposal should be accompanied by an undertaking in writing, with at least two sureties, who shall be owners of real estate in the city in their own right in the amount of the surety, and shall have held the same at least one year prior to the time of becoming such surety, that if the contract be awarded to the party or parties proposing, they will become bound as his or their surety for its faithful performance. The sureties must justify before an official authorized to administer oaths.

LIABILITY OF THE GUARANTORS (U. S. Form)—The liability of the guarantors and bidder is determined by the act of March 3, 1883 (22 Statutes, 487, Chapter 120), and is expressed in the guaranty attached to the bid.

SURETY NOT AN OFFICER OR PARTNER—An officer of a corporation will not be accepted as surety for such corporation, nor will a firm be accepted as surety for a member of the partnership. In other words, a firm as such will not be accepted as a surety on a bond for any of its members, nor a partner for a copartnership or a firm of which he is a member. Stockholders who are not officers of a corporation may be accepted as sureties for such corporation.

SIGNATURE OF GUARANTOR—When the principal, a guarantor, or a surety is an individual, his signature to a guaranty or bond should have affixed to it an adhesive seal. Corporate seals should be affixed by corporations, whether principals or sureties. All signatures to bonds should be written out in full and each signature should be attested by at least one witness, and, when practicable, by a separate witness to each signature.

ACCEPTABILITY OF SURETIES—The adequacy and acceptability of all sureties and the amount and character of the surety for the fulfillment of the contract will be determined by the parties letting the work after the proposals are opened, the award made, and the contract signed. It is sometimes customary to require that the surety be submitted for approval at least eight hours before the time bids are to be submitted. In either case, careful investigation should be made of the financial status of individual bondsmen offering themselves as sureties on contractors' bonds, and no bonds of individuals should be accepted until it is conclusively shown to the satisfaction of the city council (or proper county or state body) that such bonds afford ample security to the city (or county, etc.) for the fulfillment of the undertaking in question.

DELIVERY OF BOND—The consent of sureties should be placed in a sealed envelope with the proposal and properly addressed to the party advertising the work, but otherwise unmarked. It is suggested that the inner envelope be sealed with sealing wax.

WITHDRAWAL OF BOND OR SURETY—Neither the principal nor sureties on any bid or bond shall have the right to withdraw or cancel the same until the city council (or proper county or state body) shall have let the contract for which such bid is made, and the same shall have been duly executed.

CHANGE OF SURETIES—Bidders should not be permitted to change the sureties on the bond submitted by them if they are acceptable.

ADDITIONAL SURETIES—If at any time during the continuance of the contract the sureties, or any of them, shall die, or become irresponsible in the opinion of the city (or county, etc.), they shall have the right to acquire additional and sufficient sureties, which the successful bidder shall furnish to the satisfaction of the city (or county, etc.) within ten days after notice, and in default thereof the contract may be annulled by the city (or county, etc.), and the work carried to completion in the manner provided in the contract.

CITY OR OTHER OFFICIAL—No proposal should be entertained which contains the signature of a city (or county or state) official as surety.

EXECUTION OF THE BOND—The bond or bonds should be executed within 30 days from the date of award of the contract.

(13) THE AWARD OF THE CONTRACT TO LOWEST BIDDER—When work is to be let for which estimates have been solicited, unless previous notification to the contrary has been given, the lowest bidder should be entitled to the contract provided his proposal complies with all the provisions required to render it formal, and his prices are equitable.

ACCEPTANCE OF BID—It should be understood that an acceptance by the board (or council or state) of proposals made shall be conditioned upon the execution of the formal contract (of which the plans and specifications are a part), and the furnishing of the required bond for its faithful and complete performance. A written acceptance of a proposal will constitute a contract.

ALTERATIONS—Bidders should not be allowed to amend their estimates or proposals after the bids have been opened and before the award.

TIME FOR COMPLETION—The time required by the bidder for the completion of the work should be taken into account in considering the relative advantages of the different proposals submitted, as the work should be done with all the speed compatible with good workmanship. In other words, the element of time should be carefully considered in awarding the contract.

ANNULMENT OF CONTRACT—If the bidder to whom the first award is made should fail to enter into a contract as herein provided, then the award may be annulled and the contract let to the next most desirable bidder in the opinion of the city council; and such bidder shall be required to fulfill every stipulation embraced herein as if he were the original party to whom the award was made.

SPECIAL ELECTION—It is sometimes customary not to award a contract until after a special election, which is to be held soon after the bids are opened. In such a case each bid should be kept confidential, and treated as though the city was ready to award the contract. The object of having bids submitted before election is to determine what amount it will be necessary to ask taxpayers for the contemplated improvment. The lowest responsible bidder should be awarded the contract under the same conditions that a contract would be awarded if the election was held prior to the opening of the bids.

BIDDER'S EXPERIENCE—No award should be made to any bidder lacking in experience in work of the kind proposed, and each bidder should be required to file evidence of his ability to satisfactorily execute the proposed contract.

PREFERENCE TO BE GIVEN TO SINGLE BIDDER—Should bids for all of the contracts be received from a single bidder, and should the aggregate amount of such bids be less than the sum of the lowest bids received from separate bidders, then in such event preference should be given in awarding the contracts to the single bidder on all contracts.

APPROXIMATE QUANTITIES—The quantities to be used in canvassing the bids are approximate only, and the sum of the unit prices multiplied by the quantities furnished should be the criterion to determine the lowest bidder.

TWO ESTIMATES TO BE SUBMITTED—No contract should be awarded unless at least two responsible and competitive bidders estimate on the work as advertised.

(14) REJECTION AND MODIFICATION OF BIDS RESERVED

IN GENERAL—The right should be reserved to reject all proposals and readvertise and award the contract in the regular manner if, in the judgment of the city council, the interests of the city will be enhanced thereby. The right to return all bids before the same are opened is sometimes stated in the instructions to bidders.

WAIVING DEFECTS IN BIDS—It is generally customary to state that the right is reserved to waive defects in bids in the interest of the city (or county, etc.) if good cause exists therefor. In other words, it is customary to reserve the right to negotiate with any bidder for an amended proposition, which will best serve the interests of the city.

MODIFICATION OF UNIT PRICES—The unit prices called for in the proposal sheet should be used as the basis of value of such additions, omissions, or changes, if they are deemed reasonable by the engineer. If deemed unreasonable, or if none applicable are given, and no agreement can be reached by the engineer and the contractor as to the reasonable value of the work, then the engineer should have the right to fix the value of such additions, omissions, or changes, and no claim for damages on account of such change or for anticipated profits should be allowed.

PAST PERFORMANCE OF BIDDER—The failure of a bidder to make satisfactory progress, or to complete on time similar work under previous contracts with the city, should be duly considered in canvassing bids, and may be a valid cause for the rejection of his proposal.

(15) EXECUTION OF THE FORMAL CONTRACT

IN GENERAL—The contract should be signed and the bond furnished within ten days (Sunday excepted) after the date of the notification of the acceptance

of the proposal and the readiness of the contract for signature. The cost of executing the bond and contract, including all notarial fees and expenses, is to be paid by the bidder to whom the contract is awarded.

DOCUMENTS COMPOSING THE CONTRACT—The following documents are essential portions of the complete contract: (1) The advertisement, (2) the instructions to bidders, (3) the proposal, (4) all drawings, maps, plans, (5) the specifications, (6) specific contract, and (7) the contractor's bond.

DEFAULT OF SUCCESSFUL BIDDER—In case of failure or neglect to execute the formal contract, the bidder will be considered as having abandoned it, and as in default to the city council (or proper county or state body); and thereupon the work should be readvertised and relet, and so on until the contract be accepted and executed.

CERTIFICATE OF CORPORATE EXISTENCE—A corporation to which a contract is awarded should be required, before the contract is finally executed, to furnish certificate as to its corporate existence, with evidence to show that the officer signing the contract is duly authorized to do so on behalf of the corporation. That is to say, all companies and firms represented by agents should be required to show legal authority that said agent is authorized to sign and execute all agreements and contracts for said company or firm, and bind the same thereby.

FORM OF CONTRACT—The form of contract which the bidder and guarantors promise to enter into should be fully set forth in the blank forms, which may be inspected at the office of the engineer and to be furnished, if desired, to parties proposing to put in bids. Parties making bids are to be understood as accepting the terms and conditions in such form of contract.

UNIFORM BUILDING CONTRACT—The uniform contract adopted by the American Institute of Architects, the Western Association of Architects, and the National Association of Builders is recommended for building contracts.

IDENTIFICATION OF DRAWINGS AND SPECIFICATIONS—A contract copy of the drawings and specifications should be signed by both parties to the contract for identification, and thereafter, questions regarding condition of drawings or specifications at the time of the execution of such contract should be referred to the contract set.

WORK PERFORMED WITH EXECUTION OF FORMAL CONTRACT—Unimportant work for amounts not exceeding (say) $500 may be performed without the execution of formal contracts. In such cases acceptance by the engineer should be noted on the face of the proposal in duplicate, and one copy returned to successful bidder. Such proposals will take the place of formal contracts.

SIGNATURES TO CONTRACTS—All signatures to contracts must be written in full and each signature must be attested by at least one witness.

TRANSFERS—Transfers of a contract, or of any interest therein, is prohibited by law.

(16) CONDITIONS AND STIPULATIONS AS TO THE PERFORMANCE OF THE WORK

EXPLANATORY NOTE—The following conditions and stipulations are common to construction contracts and belong strictly to the general clauses in the specification itself, and will, therefore, not be treated fully here. They do not enter into the proposal except as being terms of the agreement, which the bidder must execute:

BOND—A bond will be required from the successful bidder for the faithful performance of the contract. (See Section 12.)

MISTAKES IN BID—The special attention of bidders should be directed to the fact that no claim for relief on account of mistakes and omissions in the bid will be considered, and that the contractors will be held strictly to their bids or their deposits forfeited.

SPIRIT OF THE PLANS AND SPECIFICATIONS—Bidders will be held strictly to the spirit of the specifications, the accompanying plans, and such instructions as may be given from time to time by the engineer. On this account bidders should be requested not to complicate their tenders by putting in alternate bids unless they be asked, with the expectation that concessions will be made after the contract is closed, in order that the work may be cheapened, because such alternative bids will not be considered. To sanction any variation or to relax stringency in any particular of any existing contract is irregular, and is likely to give the contractor an advantage which is unfair to competitors whose proposals were based on the expectation of being held to the strictest observance of the plans and specifications.

MATERIALS AND WORKMANSHIP—Bidders will be required to furnish materials and to complete the entire work to the satisfaction of the engineer and in strict accordance with the plans and specifications. All workmanship shall be of the best procurable kind both as to material and labor. Unless otherwise specified, the material furnished must be of the best quality, make and device for the purpose required and the bidder must make his estimates accordingly.

INSPECTION AND ACCEPTANCE OF WORK—Each bidder must understand that should his proposal be accepted the materials delivered and the work performed by him, at any and all times during the progress of the work, and prior to final acceptance and payment, the same shall be subject to the inspection of the engineer, or his authorized agent, with the full right to accept or reject any part thereof that in the opinion of the engineer is not strictly in accordance with the plans and specifications.

PROTECTION OF MATERIALS AND FINISHED WORK—The successful bidder will be responsible for the proper care and protection of all materials delivered and work performed by him until the completion and acceptance of and final payment for all the work embraced in his proposal, and part payments from time to time on account of such materials and work will not in any way relieve him of such responsibility.

LOCAL LABOR TO BE EMPLOYED—Notice should be given to bidders for certain work that a clause will be required to be inserted in the contract providing that only residents of the City of.....shall be employed as laborers in the contemplated improvement. In other words, the contractor to whom the work may be awarded should, so far as practicable, give preference to bona fide resident laborers and mechanics, but not at wages greater than current rates for the respective classes of work.

HOURS OF LABOR—Where the law allows only eight hours labor in a day upon municipal work, all proposals submitted must be based upon the eight-hour working day for all workmen employed.

CONVICT LABOR PROHIBITED—Often in the prosecution of the work specified the employment of persons undergoing sentences of imprisonment at hard labor, which have been imposed by courts of the several states, territories or municipalities having criminal jurisdiction, is prohibited.

SKILLED LABOR TO BE EMPLOYED—The successful bidder is to employ only skilled and reliable workmen in the performance of the work, and must agree that the engineer shall have the right to decide upon and discontinue the services of any workman employed by him on the work who does not possess satisfactory skill and qualifications or is otherwise objectionable.

PROTECTION OF NAVIGABLE WATERS—The attention of the bidders should be especially invited to the act of Congress governing the protection and preservation of navigable waters of the United States.

RISKS AND DAMAGES—The successful bidder assumes all risks and damages in the prosecution of the work.

(17) CONDITIONS AND STIPULATIONS AS TO THE COMPLETION OF THE WORK

IN GENERAL—Bidders are generally required to state the number of days they will require to complete the work, time for completion being considered as one of the essentials of the contract. Bidders should be held strictly to the time named, no allowance being made for Sundays or holidays.

STIPULATED TIME TO COMPLETE WORK—It is sometimes customary to state that all work shall proceed as rapidly as is consistent with thoroughness and good workmanship, and shall be completed within.....month after the execution of the contract.

VALUE OF EACH DAY REQUIRED TO COMPLETE THE WORK BY THE BIDDER—For the purpose of comparing bids, each day stated by the bidder as being required by him to complete the work according to the plans and specifications should be assumed as worth (say) twenty-five dollars ($25).

LIQUIDATED DAMAGES—Each bidder must understand that should his proposal be accepted the sum of..... .....dollars ($.....) as liquidated damages will be fixed for each and every day's delay not caused by the city, county or state that may occur beyond the time stipulated in his proposal for the supply of all materials and the performance of the work. The amount thus withheld should not be considered as a penalty, but as liquidated damages fixed and agreed to in advance by the contracting parties.

BONUS FOR EARLY COMPLETION—A bonus of.....dollars ($.....) per day will be paid for each and every day that the work is completed before the date specified for completion.

(18) ESTIMATES OF WORK DONE AND PAYMENTS TO BE MADE

IN GENERAL—After the acceptance of a proposal and execution and approval of a formal bond and contract, monthly payments are generally made on account of the work actually done and in place, such payments being based upon the estimated value of the quantity of such work, computed from the contract unit

value, less about ten (10) per cent., which is retained until the entire and satisfactory completion, final inspection and acceptance of all the materials and work embraced in the contract, at which time final payment of the balance due is then made. The payment for the work will be made in accordance with the contract and specifications.

SPECIAL TAX BILLS—The work is sometimes paid for in special tax bills issued against the lots and parcels of ground liable to taxation for such improvement.

DEFERRED PAYMENTS—It is sometimes customary to pay for work in deferred payments of certificates of indebtedness, secured by the revenues of the city.

PAYMENTS TO CONTRACTORS ONLY—Payments will be made only to principals. Assignments and powers of attorney to collect moneys should not be recognized.

(19) GUARANTEES REQUIRED TO ACCOMPANY BIDS

IN GENERAL—The contract sometimes requires that certain work be guaranteed and maintained in good condition for a specified time after its final acceptance and payment therefor, and the bond which is generally required in connection with the contract must also cover such guarantee.

GUARANTEEING DELIVERY ON TIME— It is sometimes stipulated that proposals shall contain a statement definitely guaranteeing the time in which (say) the pumping engine will be installed ready for service, and the bidder guaranteeing the earliest installation, other conditions being equal, will be given preference.

(20) SAMPLES TO BE SUBMITTED WITH BIDS

IN GENERAL—The bidder must submit with his proposal, at his own expense, samples of the materials and workmanship (or finish) which he proposes to use (or furnish) whenever so required by the specifications.

ALTERNATE PROPOSALS — Should the bidder desire to submit alternate proposals, then alternate samples should be submitted.

IDENTIFICATION OF SAMPLES—Samples must have the name of the bidder, the title and location of the work, and the date of proposal plainly marked thereon for identification.

ACCEPTANCE OF SAMPLES—Bidders are generally notified previous to the opening of the bids as to whether the samples submitted are acceptable to the city or county.

SAMPLES MAY BE REMOVED—Samples submitted by the successful bidder will be retained, others to be removed at the expense of the parties submitting them. It is also customary to state that samples will not be returned to bidders, but will be retained by the city whether bids are accepted or not, and no bid to be considered if not accompanied by samples.

DUPLICATE SAMPLES—The samples submitted with the proposal of the successful bidder will be retained, and when required, he must furnish duplicates of the samples at his own expense.

WHAT SAMPLES ARE TO INDICATE—Samples are to indicate the arrangement the bidder proposes to use, by one of the poorest quality and one of the best in each class, with the understanding that the material furnished is to run between the two, so that the average of the material furnished will be practically the average of the samples.

SELECTION OF SAMPLES—In case of the acceptance of any proposal represented by samples submitted, such samples or enlarged area of same grade and finish shall become standard of material and workmanship to be furnished under the contract, and on such account care should be given to make material and workmanship in samples of the kind and quality which will represent the average condition, finish, color and texture.

REJECTION OF SAMPLES—If any of the samples, in the opinion of the engineer, are not in accordance with the contract requirements they will be rejected, and the contractor is to furnish additional samples in lieu of those rejected, until materials suitable in the judgment of the engineer are submitted.

TIME IN WHICH TO SUBMIT SAMPLES—It is generally customary to require that samples of the materials to be used must be left in the office of the engineer at least 48 hours before the time fixed for the opening of the bids.

EXPLANATION OF SAMPLES—Contractors should be given an opportunity to explain samples immediately after bids are opened and read.

(21) RECEPTION OF COMPETITIVE DESIGNS

NOTICE TO BIDDERS—The City (or county or state) of.....having decided on erecting a....., now invites competitive designs for such a structure.

SELECTION OF COMPETITIVE DESIGN—The competitive plans with approximate estimates will be referred to a committee of three, one of whom shall be the city engineer of said city (or county or state), one a member of the common council (or proper county or state body), to be selected by said council (or other body), and one a consulting engineer, to be appointed by the mayor (county or state official). Said committee to examine said plans and estimates and report to the council (or other body) the plan best adapted, in their judgment, to meet the requirements of the situation. The decision of the judges shall be without appeal.

DETAILS AND SPECIFICATIONS—Proper details must be furnished for work that is not otherwise sufficiently shown. Specifications must be in ink. They shall be definite where the work is not clearly shown by drawings. Every distinctive class of work to be included in the contract must be mentioned and placed under its appropriate heading.

INDORSEMENT AND DELIVERY OF DESIGNS—The plans and specifications must be addressed to....., indorsed "Plans for....," at or before 12 o'clock m., Tuesday, ...191.. Each design shall bear a distinctive motto and contain nothing capable of designating the author, but shall be accompanied by a sealed letter bearing the same motto giving his name and address. Designs while in transit or in custody will be at the owner's risk. The sealed envelope, containing the name of the author of the design, will be kept unbroken until after the committee of award has rendered its decision.

POINTS TO BE CONSIDERED IN AWARD—The features which will have weight with the committee of award to whom the designs will be submitted will be: (1) Adaptability for the purpose desired, (2) architectural design, (3) economy in treatment, (4) rendering of drawings and specifications.

PAYMENT FOR PLAN SELECTED—The person or company whose plans shall be selected shall receive therefor the sum of .....dollars ($.....), provided he or it shall not be the successful bidder for the construction of said structure when bids for such construction shall be received and the work awarded.

RETURN OF COMPETITIVE PLANS—If it is desired to have plans or designs returned, it must be so requested, and the necessary postage stamps for mailing must be furnished. The designs in that case will be returned at the convenience of the party holding such competition.

RIGHTS RESERVED—The city (or county or state) does not bind itself to the execution of any of the designs submitted, nor does it bind itself to confide the direction of the work to the architect or engineer to whom the first prize may be awarded.

ACTING AS CONSULTING ENGINEER—The successful competitor may be required to act as consulting engineer in the construction of said work in connection with the city engineer. In such case each competitor must specify what percentage on the total cost of the work covered by the plans and specifications as let to the contractor he will charge for said plans and specifications and consulting engineering work, not to exceed five (5) per cent. thereof, and must agree to protect the city (or county or state) against any patents which might be infringed by the structure covered by its plans and specifications.

PRELIMINARY INFORMATION—The city engineer will furnish general plans and specifications on application.

(22) MISCELLANEOUS ITEMS

SCHEDULE AND LIST OF UNIT PRICES—The successful bidder shall furnish to the engineer a correct itemized statement showing quantities of labor and materials, and amount included in his estimate for each general item of work to be furnished complete and in position, including in each item its due proportion of expense and profit; the sum of the different items equaling the total amount of the proposal. The above schedule shall be for the use of the engineer at his discretion in preparing estimates for payment on account.

The successful bidder shall also furnish to the engineer a list of unit prices of the different materials entering into the work, per unit of quality, such unit prices to be used in estimating all items added to or deducted from the work included in the contract.

SPECIAL DEVICES—Every bidder is expected to include in his proposal not only everything called for in the plans and specifications, but also any special devices or methods peculiar to his system of construction, which will add to the stability or completeness of the structure, stating clearly the advantages to be derived from their use.

The Railway Freight Terminals of Chicago are to be investigated by a commission appointed by the mayor, with a view to the more systematic, convenient and economical arrangement of these terminals. The commission includes aldermen, business men and railway men; among the last are **F. A. Delano**, President of the Wabash R.R., and **S. M. Felton**, President of the Chicago Great Western Ry.

The Writing of Specifications

By H. P. Breitenbach *

The art of writing specifications has never received adequate attention, either in theory or practice. Such good specifications as are produced today have been developed by a process of elimination, but only slowly and at great cost. Better economy results if the principles which underlie such development are determined and then applied in drafting any given specification.

The Comparative Method of Writing Specifications, here explained, purposes to formulate the principles of the evolutionary process and effect their application in connection with the study of existing examples of specifications. By following this method the engineer engaged in writing specifications is enabled both to benefit by the advances made by others and to place himself in a critical attitude toward his own compositions. Thus the evolutionary process may be hastened with resulting advantage to both the individual engineer and to the profession in general.

*Instructor in English, Engineering Department, University of Michigan, Ann Arbor, Mich.

The preparation of specifications and contracts forms the subject of several comparatively recent books, written particularly for the use of engineers. But satisfactory and complete as some of these are in other respects, not one gives adequate attention to a most important phase of the problem confronting the engineer who has such documents to write.

For in studying the subject of preparing specifications and contracts, three points of view emerge. The first is the legal one, that of the lawyer, who views the situation as subject to and controlled by certain laws and statutes, which in turn are interpreted according to various judicial decisions. According to this viewpoint, he who draws up the document, be he lawyer or engineer, must frame it so equitably to all concerned as to prevent the need of litigation, so far as is possible; or, if litigation does ensue, to ensure the rights of all parties concerned.

The second point of view to be distinguished is the technical one, that of the engineer, whose primary duty as such is to see that the specifications embody the best practice recognized in his profession, so as to secure safety, efficiency, and economy.

The third point of view may be called the rhetorical one; it is that of the writer who, while keeping in mind the legal and the technical requirements, strives to express his meaning so clearly in the document that not only is no misunderstanding likely to arise therefrom, but even that no misinterpretation is fairly possible.

This last requirement in the preparation of specifications and contracts has been almost wholly neglected by authorities on the subject. Wait's monumental work concerns itself, of course, only with the legal standpoint. Johnson's standard book, useful to engineers as it has proved for many years, contains a summary of the legal principles, but is devoted mainly to consideration of the technical requirements. How actually to write the documents Johnson dismisses with a few general suggestions only. Likewise, Waddell's lectures on the subject devote only a few words to the third requirement; in these he emphasizes mainly the single element of precision, but he does not tell how to attain it. As published in book form, the lectures are accompanied by data supplied as a basis of practice in writing specifications, but again no help is offered as to the method to be employed. Like Johnson's book, Fowler's contains mainly examples of specifications with little help as to methods of preparing original documents.

Finally, Tucker's work, the most recent of all, includes, besides a digest of legal principles, a chapter especially devoted to suggestions on drafting specifications. He does not, as do Johnson and Waddell, merely quote examples of clauses found in specifications, but gives instead several documents in skeleton form, as he calls it; that is, he submits a synopsis of their main ideas. Now such a synopsis of a piece of writing, especially if it show the structure, is certainly of some assistance to a student; but in helping him to learn to prepare such documents it is only one step in the right direction.

Among practicing engineers themselves current opinion varies widely with regard to the best method for preparing specifications. Many have only a confused idea as to the possibilities of the situation. For instance, some assume that a single ideal set of specifications can be prepared which will deal adequately with any case, at least in its general phases. Others maintain that as every piece of work is unique, it requires an altogether unique set of specifications. Actual methods of preparing the documents vary accordingly. Cases have come to light where large portions of specifications have been blindly copied and incorporated in another document dealing with a different set of circumstances. Some engineers have a set of general clauses which they use for nearly every case. Others write, or attempt to write an entirely new set for each situation. No doubt many engineers have not formulated any particular ideal nor any particular method, but work in a somewhat haphazard manner.

The Comparative Method of preparing specifications recognizes and is based upon the evolutionary process through which in large measure the present-day standard of efficiency in specifications has been attained. Its aim is to forward the evolutionary process by making it both more rapid and more economical. For, on the whole, the process has been both wasteful and slow. Improvement in a clause of a specification has come about when that clause permitted unsatisfactory work, caused a monetary loss, or led to a lawsuit. In this way, engineers have profited by their mistakes; but the cost has been great. And only very slowly have engineers profited by the mistakes of others. Thus the situation may be summed up in a phrase by saying that progress has come about as a result of failures.

The Comparative Method, which endeavors to hasten the process of improvement without the necessity of such losses and failures, is not applicable in all cases, but only where a sufficient body of data can be secured to afford an opportunity for comparison. In the other cases a different method must be employed which cannot be discussed here.

The Comparative Method itself requires the formulation of the ideals toward which the evolutionary process appears to be tending; and then in accordance with these ideals three progressive steps are taken. The first is the collection and classification of the available data. The second is the comparison and organization of this material. The third is its reconstruction and improvement. The meaning of each of these will be set forth later in full detail.

The ideals toward which the evolution of specifications appears to be tending, may be studied from any of the three points of view that were distinguished at the outset. Thus, in the legal aspect, they have tended toward greater fairness to all parties concerned. As Chas. B. Dudley expressed it in his presidential address before the American Society for Testing Materials:

> At first it [the specification] had been a demand; it now became an agreement. At first it had ofttimes, perhaps, been

promulgated with something of a feeling of superiority by its maker, and received by the manufacturer or producer with a feeling of opposition or antagonism; it now became more of a compromise, and was put forth and received with a much more conciliatory spirit on both sides.

Technically considered, specifications have, of course, developed toward the ideals of efficiency and economy in their engineering results.

From the rhetorical standpoint, the one which alone concerns us, the main ideals may be named logicalness, completeness and accuracy. Logicalness refers to the interrelations of the details. The tendency here noted is to arrange and organize the material in the way that will best convey the meaning desired. Completeness refers to the need that the specifications include everything necessary, without, of course, retaining anything superfluous. By accuracy is meant definiteness and directness in details; the tendency is toward the specific as opposed to the general, to the exact as opposed to the vague.

These ideals having been formulated, the Comparative Method requires as a basis for their application, the collection and classification of as much material as possible. That is to say, as many specifications as may be had dealing with the desired subject are first obtained. Sources for such material and methods of obtaining it are suggested below.

To illustrate the method, let us suppose that an engineer wishes to prepare a specification. According to the textbooks, he would go about his task in one of two ways. He might take as model some set of specifications already used and imitate that as closely as circumstances permitted. Or he might prepare a wholly original set of specifications, formulating and expressing his requirements as well as he could. But the Comparative Method would require a somewhat different procedure, one which retains the good features of both the other methods, while seeming to advance beyond them in effectiveness.

As a preliminary, our engineer would, as mentioned above, collect all the examples possible of specifications bearing upon the given subject of his work. His first task now is to prepare a logical and consistent plan on which to base his own specification. This may be accomplished inductively, by a study of the plan of similar specifications in his collection. But especially for the engineer of limited experience, comparison had better be deferred, and the deductive method employed first. In following this method, he will first set down the main division of his subject, afterward arranging them as seems best. For example, in planning the general clauses of his specification, he may adopt such familiar headings as Scope of Work, Duration of Work, etc. These main headings are to be similarly subdivided; for example, Duration of Work will include Time of Beginning and Concluding, Progress, and the like. The engineer will receive considerable assistance in this portion of his work from the standard textbooks, especially Tucker's, which, as already mentioned, gives various synopses of specifications. Further information on methods of outlining may be derived from a textbook on rhetoric; for this particular purpose Earle's Theory and Practice of Technical Writing is probably best adapted. If, however, the engineer makes use of such an analysis as that in Tucker's book, he will derive considerable advantage from putting it in outline form throughout. For example, the topic "Laborers" as analyzed on page 260, might better be outlined as follows:

(1) Preference as to residence and nationality.
(2) Hours.
(3) Board:
  a. No farming out of commissary.
  b. Choice of places to be left to men.

Also similar topics should be brought together. So the heading "Workmen," referring to their competency and to their liability to discharge by the engineer, should be brought into evident relation to the topic headed "Laborers."

The second essential of a good specification, completeness, may be studied in very close connection with logicalness, and by similar methods. In preparing a list of headings with the idea of completeness in mind, every possible topic that might be of use in any way should be included. While not all of these need be employed in any given specification, the list will serve as a check to guard against the omission of anything essential. In preparing such a list of topics for general clauses, considerable help may be derived from an article entitled "Schedule of 120 General Clauses" (Eng. News, 51:377). In this connection the suggestion of the author is worth noting:

> In the actual writing of specifications it is not necessary to assign a separate paragraph to each of the 120 clauses that are here listed, even if all of them were used; but in order that no important provision may escape unnoticed it is well to number each provision as we have done, for the purpose of checking the written specifications. In writing each general clause, any desirable number of these 120 single clauses may be grouped together.

With a list like that above-mentioned as a foundation, the engineer might easily build up for himself an extensive checklist which would prove of service to him in the preparation of any specification. Help in making his list complete will be derived from reading other specifications, and from articles in technical journals, etc. No doubt the list would be more convenient and accessible if kept in card-index form.

As already suggested, however, the requirement of completeness needs to be interpreted relatively, not absolutely. Unwarranted inclusion or elaboration of details will divert attention from matters of greater importance. In short, conciseness of expression should be sought for, but never at the expense of the other qualities mentioned, which are more fundamental.

Our engineer's final task is to secure accuracy and definiteness in writing the clauses of his specifications. As a basis for this he will compare the individual clauses of similar import in his collection of documents, with the idea of selecting the one that is expressed the best and of improving upon it if possible. Take for example so simple a detail as indicating the time for beginning work. This, it would seem, would admit of little difference either in method of specifying or manner of expression. But consider the five following clauses all taken from recent specifications:

> The Board of Chosen Freeholders reserves the right to determine the time for commencing the work.
>
> The contractor shall begin work immediately after the execution of the contract.
>
> The contractor will be required to commence work under the contract within 30 days after the date of notification of approval of the contract by the Chief of Engineers, U. S. Army.
>
> The contractor agrees to commence the work herein required to be done within 10 days after the signing of this contract, unless the Board of Trustees shall authorize a further delay.
>
> The contractor shall begin work within 30 days after the contract has been awarded.

Of these clauses, the first does not define the time for commencing work at all; the second limits it by the indefinite "immediately;" the third makes it depend upon a notification the time of which cannot be forecast; the fourth begins well enough, but all definiteness is removed by the qualifying clause beginning "unless." The fifth is the most specific in meaning, and therefore, other things being equal, its form of expression is to be preferred. For the sake of illustration, it is assumed that nothing in the nature of the engineering situation makes an indefinite statement necessary or desirable.

The question, then, is not whether a sufficient interval of time has been afforded the contractor in which to prepare to begin work; the question is, from which method of statement can he learn most definitely exactly how much time he is allowed.

Having, as in this case, selected the clause that seems most accurate and specific, our engineer may then proceed to improve upon it if he can, and adapt it to his particular purpose. Of course, the opposite procedure might be used; that is, one might first write his own clause as well as he could, and then compare it with others to see if it could be improved.

It need scarcely be said, it would seem,

that except for some special reason all the ideas in a specification should be expressed in complete sentences, and that these, according to the first requirement, should be logically related. Yet the following quotation from a recent specification indicates that the caution is not unnecessary.

All exterior walls of brick equal to best home product and faced on two sides and return quoins with gray mottled Roman brick, the west and north and east sides faced with selected home brick as per sample.
Dampproofing at ground level, also all brick walls rendered with good coat of coal tar, applied hot, before plastering.
Finished cement floors, entire cellar.
Cellar ceiling and 2-in. partitions; one coat of plaster, neat, smooth finish.

Here, to be sure, we have no real specification at all, but only rough, disjointed notes from which the specification ought to have been built up. But while this is perhaps an extreme case, many current specifications because of their inexactness in details afford ample opportunity for disagreement, sometimes leading to litigation. James W. Rollins in a paper read before the Boston Society of Civil Engineers (See Jour. Assocn. Enging. Soc., July, 1907; or Eng. News, Oct. 3, 1907) quoted several such clauses, of which the following is an example: "A pile shall be at least six inches at tip and not less than 30 ft. long." "Does this mean," Mr. Rollins asks, "that the minimum of 6 ins. for tip and 30 ft. for length shall be allowed to be used, and as much larger tips or longer length as the engineer may require, or does it mean that no pile can be required driven with a larger tip than 6 ins. and a longer length than 30 ft?"* Another example, brought to the author's personal attention for his judicial interpretation, reads: "Imbed six 1" cup bars also the ⅝" bars in concrete shell encasing all steel columns, as shown on detail sheet No. 4." The question that arose was thus expressed: "According to the above paragraph of the specifications would you understand that steel bars are to be furnished for *all* steel columns or only the particular columns shown on detail sheet No. 4?"

Another example, cited by Major C. E. Gillette (see ENG. NEWS, May 30, 1907),

is a case where an engineer first wrote his specifications calling for different prices for excavation at different depths, clearly expressed as so much for "less than 6 ft.," so much "between 6 ft. and 10 ft.," and so on. He revised the specifications to read so much for "excavation less than 6 ft." and so much for "excavation less than 10 ft." and so much for "less than 14 ft.," leaving it doubtful whether or not separate prices were to be paid for different depths at the same place in a deep trench. That engineer's client, a municipality, lost at least $180,000 on that contract, largely made possible by that change from clearness to vagueness.

*This clause, as to the meaning of which Mr. Rollins appears to be in doubt, would probably raise no such question under ordinary conditions. It exemplifies, however, what has already been said, that in writing specifications the aim should be not merely to express one's meaning clearly, but to make misinterpretation fairly impossible.

In the last case, it will be apparent, if the engineer had taken the trouble to compare even his own versions of the same clause, he must have seen that the first one was the more accurate and definite, and hence to be preferred.

The advantages of the Comparative Method, as thus illustrated, are that it permits the engineer to avail himself of the results obtained by others and also of those afforded by his own efforts. Furthermore, it enables him to attack the problem of writing a specification in separate phases, instead of as a whole merely. So by concentrating his attention on one phase at a time, he can deal with each more effectively.

Two practical difficulties, however, seem to stand in the way of the general adoption of the plan. One is that it seems to require more time than the ordinary methods. This, however, is not the case in the long run. It would, of course, take more time for the first specification prepared in any class, but subsequent documents in the class could be prepared in much less time than formerly.

The other and more important difficulty is that of securing copies of specifications for purposes of comparison. Engineers no doubt are sometimes jealous of their personal rights in specifications and are unwilling that these should have any greater publicity than is necessary; sometimes, too, they are over-modest in regard to the value of their own documents, and hence unwilling to exhibit them. But such cases are rather the exception; at any rate, most engineers, if aware that their specifications would be of any professional value to their brother engineers, would doubtless be glad to advance the interests of the profession.

Something more than individual action seems called for, however, if the interest of any large number of engineers is to be enlisted. Collections of specifications ought to be made and located where they may be of general service. Such work may well be undertaken by at least two existing agencies. One is the technical schools; by appealing to their graduates they could doubtless secure most useful collections of material. The second is the great engineering societies. If they secured from all their members copies of their best specifications, perhaps with annotations indicating their success, what a fund of valuable knowledge would be made available for the profession.

Pending such a consummation, the individual engineer may make some progress in forming a personal collection. Copies of government and municipal specifications are generally easy to obtain. Probably too, copies of other specifications may be secured from fellow-engineers, either by exchange or simply on the ground of professional courtesy.

As already noted, the Comparative Method is not readily applicable in some cases because of the lack of data for comparison. In other cases, the work of securing a standard set of specifications has been pretty effectually accomplished. But these represent the two extremes; between them lies a vast field where the method will be found applicable and useful.

In conclusion, the interrelation of the three standpoints distinguished at the outset may be further indicated. The lawyer's function in the preparation of contracts and specifications is now generally recognized. It is pretty well understood that someone who fully comprehends legal principles in their bearing upon engineering must be consulted when the documents for an engineering project of any magnitude are prepared. Such a person usually draws up the contract proper, or "covenants," and looks over the specifications, etc. in a general way. This person may be a lawyer who has devoted especial attention to the legal aspect of engineering, or he may be the engineer himself who has studied law for this purpose.

But there is a third standpoint also, whose importance has not been so fully appreciated. As documents for the expression of thought, both contract and specification are subject to the principles of rhetoric, and so fall within the province of the writer as such. Now by the nature of his training the lawyer is more or less prepared to assume the rhetorical viewpoint; for throughout its course the law never parts company from language. The engineer, however, for obvious reasons is not so well prepared in this respect. Consequently, if he is to assume the third standpoint as well as his own, he must do so with more of a conscious effort. The principles of rhetoric come to his assistance in two ways: first, in suggesting economical and efficient methods of composition; and second, in encouraging on his part a critical attitude toward his own productions. In both composition and criticism the Comparative Method, as outlined above, will, it is believed, prove of service to the engineer.

The Coming of New Varieties of Engineer goes on apace. Circulars just issued by the U. S. Civil Service Commission announce examinations shortly to be held for "Engineer in Forest Products (Male)" and "Ballistic Engineer (Male)."

A circular received in the same mail from the American Museum of Safety begins as follows:

The new American idea of the Safety Engineer, an accident prevention specialist, will be brought to the notice of world-industrialists at an International Safety Congress to be held in Milan, May, 1912.

The Fire at Houston, Tex.

By J. W. Maxcy*

Probably the most destructive fire that ever visited the state of Texas was that in Houston during the early morning of Feb. 21, 1912. The origin of the fire is not yet known, but the city fire marshal is making thorough investigations and will submit a report in a few days. From the best information, it seems that it originated in a two-story frame dwelling, located at the corner of Opelousas and Hardy Streets, in a northeasterly direction from the center and congested value district of the city. The fire was reported about 12:30 a.m.

On the night of the fire a heavy gale was blowing from the northwest at the rate of 40 miles per hour and this swept the flames with great rapidity in a southeasterly direction, crossing the Houston Ship Channel [Buffalo Bayou—Ed.] and ending in the destruction of the barns of the Houston Packing Co. [located about a mile and a half from the origin of the fire—Ed]. The main plant of the company was saved by the combined efforts of its well organized fire-fighting force and that of the city under the immediate command of Fire Commissioner Kohlauff.

Owing to the inflammable material generally used in the construction of the property destroyed and the rapidity with which the flames spread, the fire was never under control by the fire department, although its members arrived promptly and fought bravely.

[The area destroyed, as indicated by a sketch map published in the Houston *Post* of Feb. 22, in conjunction with the Fire Underwriters' report (No. 126, June, 1910) on Houston, Tex., ranged from two to eight city blocks in width, the latter along the Bayou; then narrowed to a point on the north side of the Bayou to be continued on the south side, some blocks farther east, where a relatively small area was burned over.—Ed.] The burned area included 13 industrial plants, 129 buildings of all sorts, 116 box cars, a number of which contained valuable contents, 9 oil-tank cars, and approximately 40,000 bales of cotton. A conservative estimate of the loss places it at $4,000,000, with insurance amounting to between $2,500,000 and $3,000,000. The thoroughness of a cotton fire with a strong wind behind it is now shown by the ruins of the Cleveland Compress [on the south side of the Bayou—Ed.]. At this point about 30,000 bales of cotton were destroyed, and it is interesting to note how little remains of the structure and its contents.

Another interesting feature of the ruins is the burned cars belonging to the numerous railways in this part of the city, shown by the accompanying panoramic view. The loss was small in comparison with the number of cars in the district at the time and shows good rescue work on the part of the railway organizations.

Although the hour (near midnight) was favorable for accidents and fatalities, it is a pleasure to relate that not a human life was lost nor any one seriously injured.

The destruction of the industrial plants has thrown many men out of employment temporarily, but the city government of Houston has with commendable promptness provided immediate employment for a great number of them on street and other municipal work.

The many homeless are being well cared for by charitable organizations, assisted by liberal donations from private citizens. The immense new auditorium, school and other public buildings have been equipped and peopled with many families of fire sufferers.

Our entire city is very thankful for the generous and unsolicited offers of assistance which have been pouring in from all directions, but Houston pride glories in its ability to liberally care for all with home resources.

Every great disaster teaches a lesson that if heeded results in ultimate good. Houston's lesson, although dear, will result in:

(1) The construction of better and more sanitary abodes for the housing of our worthy producing population, and the substitution of permanent, fire-resisting materials for the inflammable wooden structures of the past.

(2) The enactment of proper building laws for new work in this district, which will require the use of fire-resisting material, the proper use and distribution of fire walls, and the installation of better retarding, confining and extinguishing devices.

(3) The building of larger and better plants with a proper eye to improving the condition of the employed and adding to the civic attractiveness of the greater city.

To the engineer and city builder the conflagration emphasizes the necessity of giving more study to the reduction of fire hazards, of barriers for arresting fires, and of planning streets so that fires can be reached promptly and fought from every angle.

The entire district will be immediately rebuilt on a larger and grander scale, and that is how Houston will profit by the fire of 1912.

Panoramic View of a Portion of the Area Burned

*Civil Engineer, Houston, Tex.

Co-operative Tie-treating Plants for the joint use of a group of railways which are too small individually to have plants of their own, have been suggested. The suggestion was made by F. P. Smith, Superintendent of Way and Structures of the Indianapolis, Columbus & Southern Traction Co., in a paper read at the annual meeting of the Central Electric Railway Association. He did not consider it advisable for a railway having less than 100 miles of track to establish a timber-treating plant, but thought that electric railways in the same territory might coöperate in the construction and operation of such a plant. Not only the treatment but also the purchase and inspection of timber for ties and other purposes could be handled economically through such a central plant.

Transit Developments in London, England

By H. Raynar Wilson*

There are in Greater London 146.90 miles of street railway, of which all but 7.87 miles is municipally owned.

The Roads Improvement Association recently addressed a memorial to the Board of Trade as to the obstruction to general traffic in London by trolley cars. It was pointed out that the increase of speed and consequent facility in the passage of traffic, which the introduction of the motor omnibus and of other vehicles propelled by mechanical power has secured, was to a large extent neutralized by the obstruction due to trolley cars.

The Association claimed that this obstruction was due, among other causes, to the running of an unnecessary number of trolley cars during those periods of the day when street-railway traffic was small. The Association suggested that a reduction of from 30 to 50 per cent. might, generally, be made in the cars in service between 11 a.m. and 4 p.m.

One of the evils of municipal bodies competing with private corporations is evident here. The trolley cars of the London County Council compete not only with the railroads, but with the omnibuses, which are privately owned.

In Engineering News for April 13, 1911, appeared an article on London traffic and reference was made there to the reports issued yearly by the London Traffic Branch of the Board of Trade. From the fourth annual report, dated Oct. 31, 1911, we learn that there were 1200 motor omnibuses licensed in London and 1103 horse-drawn.

Up to the early part of 1908 motor omnibuses cost from 24c. to 28c. per omnibus mile, but now the running expenses are only about 17c. per mile. The earnings vary on different routes and according to the weather, but may be averaged at 21c. per omnibus mile.

Omnibuses use the streets free of toll and pay no taxes beyond those for the premises they occupy. Internal-combustion omnibuses, which form 95.5% of the whole in London, however, pay the petrol tax, which is handed over to the Road Board of the Government for the improvement of the roads of the Kingdom. This works out at 6c. per omnibus mile.

Street railways pay taxes on their track and the London County Council had to pay last year $495,000 for its lines, which works out at 0.016c. per car mile.

The receipts during 1910 from the street cars of the London County Council realized 22.56c. per car mile. The net earnings were 9.60c. per car mile as against 10.12 to 10.32c. for the four preceding years. This reduction is accounted for by the fact that in the early stages of conversion from horse cars to electric many of the most remunerative routes were taken first in hand, whereas now less paying routes are included.

It is now necessary to refer to another point that will be of interest to American readers. In the reign of William and Mary (1689-1694) a tax was imposed on travelers. In 1832, when railways were being introduced, a tax was put upon travelers by rail of ¼c. per passenger mile. This was changed in 1842, to 5% on the total receipts. In 1844 an Act was passed which called for at least one train each way per day to call at all stations and to convey passengers at fares not exceeding 2c. for each mile traveled. The Act provided that "the carriages in which passengers shall be conveyed by such train shall be provided with seats and shall be protected from weather." Where these conditions were complied with the tax on such fares were waived. Until recent years these trains were known as Parliamentary Trains.

In 1883 a further change in the law was made by the Cheap Trains Act, by which the passenger tax was removed from all fares rated at one penny per mile or less and that on higher fares was reduced provided the companies carried workmen at cheaper fares.

On street railways, workmen's fares are compulsory and in London the long distances that workmen are carried at low fares has caused an increase in the working expenses without a corresponding increase in the receipts. The cost of running workmen's cars exceeded the receipts from them by $330,000, for the year ending March, 1911. Of the total car mileage, 11% was run at workmen's rates, which realized 15.2c. per car mile as compared with 22.83c. for ordinary cars. In addition there were 25,400,000 persons traveled in ordinary cars after 12 m., with workmen's return tickets, which meant a further loss of $250,000.

*96 Hurlingham Road, London, S. W.

IN THE HOUSTON FIRE OF FEB. 21, 1912

Figure of the Earth—One of the things accomplished during recent years by the United States Coast and Geodetic Survey is an accurate determination of the figure of the earth, which was made possible by the extensive triangulation net which extends over the country. For this purpose the United States with an immense length and breadth of territory and highly efficient methods has the advantage over any other country in the world of anywhere near the same extent of territory. In speaking before a meeting of Section D, of the American Association for the Advancement of Science, in Washington, D. C., Dec. 28, 1911, Mr. William Bowie, Inspector of Geodetic Work of the Coast and Geodetic Survey, stated that other determinations of the shape and size of the earth would probably be made in the future. In this connection, he said, it was noteworthy that the Mexican Government has extended a primary triangulation 10° along the 98th meridian, which will connect with the primary triangulation of the United States in the vicinity of Brownsville, Tex. The Canadian Government has also begun primary triangulation to control its public land surveys. If the triangulation of the three countries is made continuous, the dimensions of the spheroid most nearly representing the figure of the earth can be determined with very great precision, as the triangulation would thus cover an entire continent.

Hypochlorite Plant, Cleveland, Ohio

By C. F. Schulz*

A temporary plant for regulating the charge of hypochlorite used to reduce the bacterial contents of the water supply of Cleveland, Ohio, is described. Calculations for proportioning the amount of chemical to the volume of water being treated, so as to give a fixed unit strength of dosing, are given.

*Superintendent and Chief Engineer, Division of Water Supply and Electricity, Cleveland, Ohio.

The health department of Cleveland, Ohio, having been of the opinion, in 1911, that the water supply of the city required disinfection without delay, the water department erected a temporary plant which was put in operation on Sept. 11, 1911.

The plant is housed in a two-story frame building, 28x38 ft. in plan. It consists (Fig. 1) of two 45,000-lb. wooden solution tanks 11 ft. 8 in. inside diameter at the bottom, 11 ft. 5 in. diameter at the top and 7 ft. 4¼ in. deep, placed on timber posts so that the bottom of the tank is at a height of 6 in. above the main floor of the building inclosing the same. Above these two solution tanks is placed a 270-gal. mixing tank, 4 ft. 2 in. in diameter at the bottom, 4 ft. diameter at the top and 3 ft. 4 in. deep. This tank is of wood, but is lined with an acid-proof bitumastic enamel, to protect the wood from being rapidly eaten away by the chlorine. The mixing tank is equipped with a stirring device, operated by a 3-hp. gasoline engine.

Below the solution tanks are two small galvanized-iron rectangular orifice tanks. From these orifice tanks a 2-in. pipe extends to a shaft and a tunnel supplying the pumping engines.

The mixing tank is supplied with water from the city main through a 2-in. pipe equipped with a meter for measuring the quantity of water used, which is further checked by float gages in the solution tanks, indicating the quantity of water in the tanks. This 2-in. pipe enters the mixing tank from below. From a point about 6 in. below the top of this mixing tank two 4-in. pipes extend, equipped with valves and so arranged that the water can be discharged alternately into either solution tank. Two-inch discharge pipes are connected with the solution tanks at 6 in. above the bottom and terminate at the orifice tanks (Fig. 2). The openings of these discharge pipes are equipped with float valves so as to maintain a uniform head of water above the discharge orifices in the orifice tanks. A 4-in. drain pipe is connected with each solution tank for draining the same and removing the sediment.

The orifices consist of brass plates (Fig. 2) into which rectangular openings ½ in. wide have been cut. The length of these openings can be varied by means of brass slides equipped with pointers traveling over a brass scale. The orifices were calibrated to read in pounds of solution discharged per minute by means of a ⅝-in. water meter in the supply pipe to the orifice tanks. The water level was kept constant and 12 in. above the orifice slide. Assuming the weight of 1 cu.ft. of water at 62.4 lb., the following rates were observed and marked:

20	lb.	per	min.	=	1	cu.ft.	in 3	min. 7 sec.
30	"	"	"	=	1	"	" 2	" 5 "
40	"	"	"	=	1	"	" 1	" 34 "
50	"	"	"	=	1	"	" 1	" 15 "
100	"	"	"	=	1	"	"	" 37.5 "
130	"	"	"	=	1	"	"	" 29 "

The scales were marked in 10-lb. intervals from 0 to 150 lb. per minute. Assuming that the strength of the solution be 0.0037 available chlorine and that we wish to add 0.7 part per million gallons of water pumped, the amount of solution to be added per minute for a pumpage rate of 100,000,000 gal. per day would be

$$\frac{100{,}000{,}000 \times 8.34 \times 0.0000007}{24 \times 60 \times 0.0037} = 109.6 \text{ lb.}$$

or 1.096 lb. per minute per million gallons per day.

In preparing a solution and delivering the same to the water in the tunnel, the method of procedure is as follows: Water enters the mixing tank at the bottom at the rate of about 100 gal. per minute, discharging at this rate through the 4-in. overflow pipe into the solution tank. The chloride of lime is added to this mixing tank at the rate of about 8 lb. per minute, the water in the mixing tank being very thoroughly stirred by means of a stirrer driven by the gasoline engine. One drum of bleaching powder is weighed and mixed at a time and the quantity of water passing through the mixing tank and discharging into the solution tank is governed by the weight of the bleaching powder so that the solution shall contain 1% of the powder or approximately 0.37% of the chlorine. The drums average about 350 lb. of bleaching powder each, which corresponds to 35,000 lb. of water. About one hour is required to add this quantity of water.

After standing in this solution tank for a period of about five hours, or during the time required for the emptying of the other solution tank, and when the other

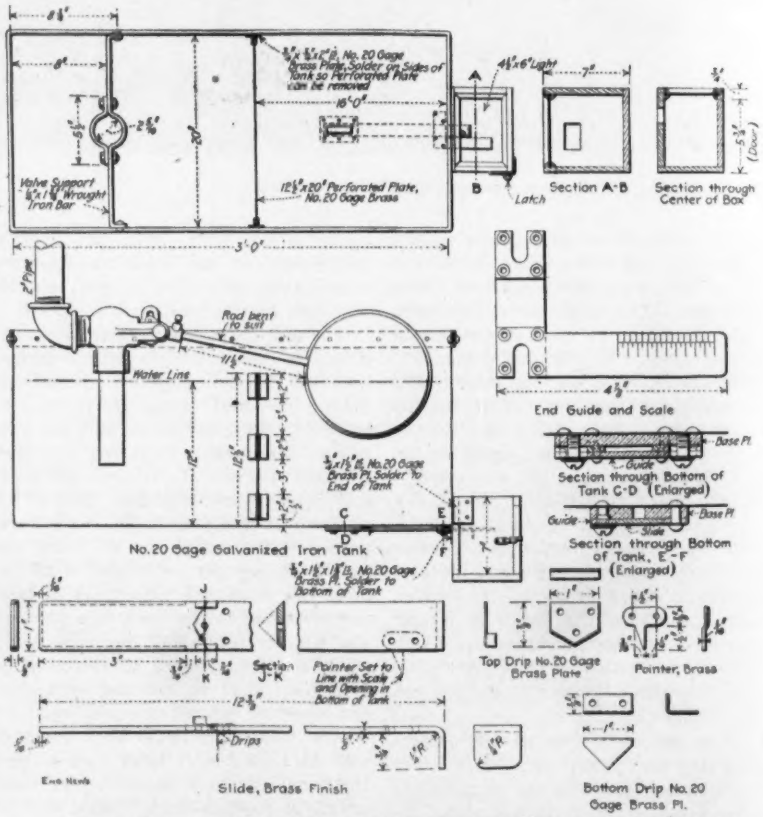

No. 20 Gage Galvanized Iron Tank
Section A-B
Section through Center of Box
End Guide and Scale
Section through Bottom of Tank C-D (Enlarged)
Section through Bottom of Tank, E-F (Enlarged)
Section J-K
Top Drip No. 20 Gage Brass Plate
Pointer, Brass
Slide, Brass Finish
Bottom Drip No. 20 Gage Brass Pl.

FIG. 1. PLAN AND ELEVATION OF HYPOCHLORITE MIXING AND SOLUTION TANKS AND MIXING MACHINERY, WATER-WORKS OF CLEVELAND, OHIO

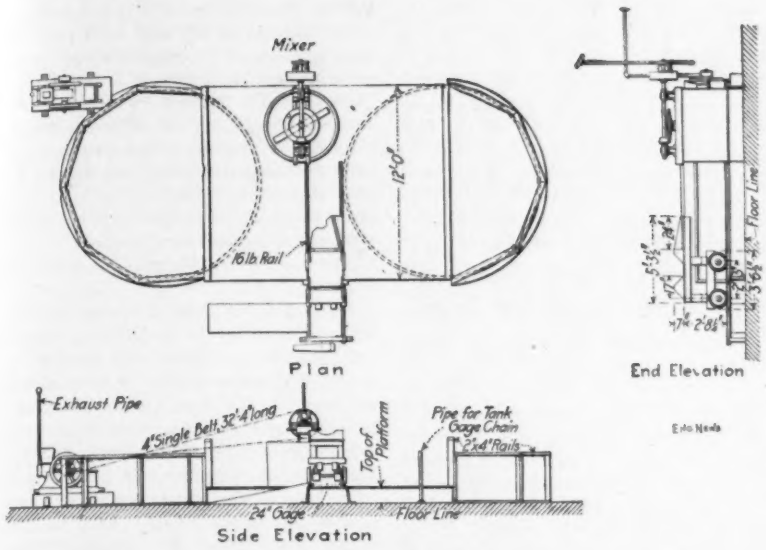


FIG. 2. DETAILS OF ORIFICE BOX, CLEVELAND HYPOCHLORITE PLANT

solution tank is empty, the solution is discharged from the solution tank into the orifice tank and from the orifice tank to the tunnel and here mingles with the water in the tunnel. A portion of the water containing the solution goes to a 15,000,000-gal. pump, in a temporary engine house, but most of it flows through the gate and screen wells and through the aqueduct and pump wells to the pumps in the main building.

Outside of the engine house and west of it is a header with which all of the discharge pipes of the pumps connect, so that if the mixture entering the various pumps should not be of uniform strength this defect is overcome in the header. After leaving the header the water is forced through two 48-in. discharge mains extending from Kirtland Station to the distribution system. Each of these mains is equipped with a check valve at a point about 815 ft. from the station, where it is again subjected to agitation so that there can be no doubt but that the chlorine is uniformly distributed in the water after it leaves the pumping station and passes through these check valves.

At present three pumps, with a total capacity of 65,000,000 gal., take water through the aqueduct. About June, 1912, the 15,000,000-gal. pump will be shut down and new ones put in use. This will bring the pumping capacity up to 100,000,000 gal. a day.

The plant was built under the general direction of Leslie C. Smith, who at that time was superintendent of the Water Division of the Department of Public Service, Cleveland, Ohio.

Letters to the Editor

A Good Word for an Engineer

Sir—Your editorial, in your issue of Feb. 22, "Does the Punishment Fit the Crime?" referring to Engineer Charles G. Elliott, of Washington, D. C., was interesting to me because in bidding on drainage contracts I have frequently met Mr. Elliott on drainage-district work where he had been called in as an expert from the U. S. government to assist the land owners in devising the most economical manner to drain the land. I have never heard any person mention Mr. Elliott but what they spoke highly of him and very frequently mentioned his conservative manner. I have heard local engineers express surprise that a man in Mr. Elliott's position should be so unassuming and so modest in his mode of living and his traveling expenses. From what I have seen of Mr. Elliott and also judging from the high character of men that I have heard indorse his good sense and conservativeness I am inclined to think his accusers will bear watching.

H. B. WHITNEY.

Villisca, Iowa, Feb. 24, 1912.

[We have also received from engineers resident in Washington and personally acquainted with Mr. Elliott and his work and with the influences which are behind the present attack upon him, personal letters expressing high appreciation of Mr. Elliott and condemnation of those who are pressing the charges against him.—ED.]

The Sheboygan Standpipe Failure

Sir—I have noted Geo. M. Peek's letter in your issue of Feb. 12, 1912, on the failure of the Sheboygan standpipe. In explanation of not having gone more into detail as to the construction of the standpipe in the article published in your issue of Feb. 1, I might say that it was the purpose of this article to emphasize the importance of careful and intelligent supervision of such structures during extremely cold weather when ice would accumulate to such an extent as to render a structure even properly designed, unsafe, rather than to make an analysis of the stresses existing in the plates at the time of failure.

As a matter of interest, and in reply to Mr. Peek's inquiry for more details, I wish to say that the 6-in. lap referred to in the article was not adhered to from top to bottom, but was proportionately decreased toward the upper sections. The ten upper rings were singly riveted, both horizontally and vertically, and the diameter of the rivets and spacing was in proper proportion to the thickness of the plates.

It is the opinion of the writer that even though the bottom rings had been made up of plates 1 in. in thickness (which, using Mr. Peek's efficiency of 58%, would have been recommended) the structure would have been severely weakened by the same forces which caused the collapse and a repetition of these conditions would have resulted in failure.

As to the joint efficiency of 75%, the author realized at the time that the theoretical efficiency was nearer 60%, but, as stated in the article, the line of rupture was not confined to the joints, but shattered the plates in an irregular course. In fact, an examination of the wreck shows that the vertical line of rupture in the bottom rings was not confined to the vertical seams. The rupture commenced at the first vertical seam near the old

fracture referred to in the article, then followed up through the plates in the 2d, 3rd and 4th rings. The author therefore *assumed* a joint efficiency of a higher percentage than would be calculated theoretically.

In reply to the editor's note as to "The Manual of American Water-Works" for 1897, stating that the material was of iron, the writer will say that a piece of one of the bottom plates has since been tested by being heated to a red glow, then immersed in cold water, with a result that the material hardened and showed characteristics of tank or plate steel, as stated originally. At the time of the failure, however, the material being frozen, it was a difficult matter to determine whether the material was wrought iron or steel.

JERRY DONOHUE.

Sheboygan, Wis., Feb. 27, 1913.

Civil Service Examination for Draftsman, U. S. Lighthouse Service

Sir—The following questions were given at a U. S. Civil Service examination, Jan. 28 and 29, 1912, for the position of Architectural and Structural Steel Draftsman, Lighthouse Service, at $1500 per year, for one year's service at San Francisco, Calif.:

MATHEMATICS—PURE AND APPLIED. ANSWER FOUR ONLY

(1) A wall is 25 ft. high above the level of an observer's eye. It supports a flagstaff 11 ft. in length. What distance horizontally from a vertical line through the flagstaff will the eye of the observer be, so that the flagstaff will subtend the maximum angle?

(2) A triangle is inscribed in a circle. Prove that the product of two sides equals the perpendicular from the vertex to the other side multiplied by the diameter of the circle.

(3) Divide 113 into two parts such that the quotient obtained by dividing the one by the other is 2 and the remainder 20.

(4) Solve for x and y:

$$x^2 + y^2 = 29$$
$$x^2 - 2xy = 5$$

(5) Tan = $\frac{1}{4}$. Find sin, cos, sec, csc and cot.

SURVEYING—TOPOGRAPHICAL AND HYDROGRAPHICAL. ANSWER FOUR ONLY

(1) Name the different methods of measuring the flow of a river and describe each.

(2) Describe the solar attachment used with the ordinary engineer's transit, and its use.

(3) How would you make a profile with a level?

(4) Describe briefly the system of land subdivision used in the United States.

(5) Describe the aneroid barometer and its use.

STRUCTURAL MATERIALS AND CONSTRUCTION. ANSWER FOUR ONLY

(1) Define coefficient of elasticity and elastic limit of structural metals.

(2) What is dry rot; wet rot; the teredo and its effects?

(3) How would you make the pattern for a plain circular c.-i. column, and how would you mold it?

(4) How would you make a surface inspection of sheet steel?

(5) Describe different forms of cofferdam materials and the construction of cofferdams; describe the pneumatic process and the freezing process of excavation and when you would use each.

DRAWING. ANSWER ALL

(1) To draw 10-ft. contours on about a 20-sq.in. paper, having given points whose elevations were marked on the area, and which varied between 0 and 100.

(2) To trace a 7000-ton mushroom anchor on cloth, given the drawing of it.

(3) Make a sketch of the eaves and cornice of an ordinary frame dwelling.

Time for mathematics and surveying, together five hours.

Time for structural materials and construction and drawing, together seven hours.

"CULEBRA."

Land-Side and River-Side Levee Borrow Pits and the Principles of Earthwork Drainage

Sir—I have read with interest and I hope with understanding the letters of Messrs. Dabney, Chamberlain, Parsons and Sellew, engineers interested in levee construction, and am appreciative of and thank them for their notice of my inquiry in your issue of Jan. 11, 1912.

In that letter I rather clumsily stated my position by saying that I did not know and had not heard any controlling reason other than a purely economical one for adhering to the rule that material for levees must be taken from the river side of the levee, supplementing this statement in the following language (the two should be taken together):

If the same rules as to cutoff walls, thickness of earthwork, slopes and berms and, as to hydraulic grade lines, and others affecting stability of earthen embankments, dams, canal banks, etc., to enable them to sustain water pressure and guard against wave wash and scour be applied to levees it would seem of no importance whatever for technical reasons where a builder of levees gets his material, whether from the land or river side.

I see no reason to change my position. Having in 1882-3-4 constructed some 4,000,000 cu.yd. of levee extending at intervals along the Mississippi River for about 200 miles of its course, and having fought to maintain both the new and old structures through two mighty floods, 1882-3, 1883-4, and having devised, specified, supervised the construction of, and acted as assistant engineer in the construction of about one hundred and sixty miles of navigable canals of large size, about one hundred miles of which were over marsh, and cultivated alluvial lands, and stratified alluvial deposits involving over 15,000,000 cu.yd. of earthwork, I can hardly be regarded as ignorant of the various kinds of failure of earth embankments and of the subject matter of the excerpts and quotations, given in the letters referred to, namely: Sand boils, cut-backs, sloughing back slopes, loblolly surfaces in rear of levees, supersaturated and semifluid mud banks, etc., etc., and their causes and remedies.

Nearly all the failures of levees that are charged against land-side borrow pits seem due to the practical disregard, on account of cost of application, of one of the rules to be followed in establishing the stability of earth dam construction, applicable alike to all of this class, including levees. Without being too precise in statement it is this:

For stability against water pressure the upper surface of material supersaturated by water, due to percolation, should not emerge above the toe of the back slope of the embankment or dangerously approach the natural surface in the rear of the embankment.

The usual inculcation is somewhat wider:

Prevent water passing through, under, or in vicinity of the embankment under sufficient head, velocity, and quantity to wash out, undermine or overthrow the structure; and it appears that usual and generally applied precautions would have prevented 90% of the failures, and the others would have occurred had the material been taken from anywhere. In several of the cases cited, it may be that earthworms, crayfish, doodlebugs, burrowing animals, or casts of decayed vegetation provided ways for water to pass with high enough velocity to enlarge the small channels made by them and to destroy the levees. This is a source of trouble to earthwork engineers most difficult to provide against, particularly as it is likely to become effective at any time during or after construction, irrespective of borrow-pit location.

In a majority of such cases good muck ditches, or core walls; careful construction; rolling the base of the levee with a heavy roller or other compacting of material; or even in some cases the addition of extra material and weight, would have resulted in breaking down existing holes made by small animals and have made the earth better able to resist percolation or filtration.

Other causes of failure, such as supersaturation of the embankments and bases, have often been very effectually prevented and remedied by proper drainage and by the resulting artificial lowering of the upper limiting surface of supersaturated material, when they cannot be economically remedied by increasing the dimensions of the embankments.

This remedy by drainage is oftentimes practicable in levee construction along rivers that flow in beds of their own make, for the slopes to the rear are usually quite steep. In 1883 in case of two levees where the ground in the rear was converted by seepage water into a loblolly, and it was necessary either to stop construction of the levee and allow it to fail from supersaturation or overtopping or in some way obtain material from the rear after drainage (in ignorance, perhaps, of the sacred character of the rule-of-thumb in question, although I myself, after consulting state engineers, first incorporated it in government specifications, with the object of meeting the requirements of economy). I had quite deep ditches

dug near and parallel respectively to the foot of the levee back slope and then drained these ditches directly to the swamp in the rear. In a short time not only the supersaturated surface material behind the levee became workable, but also the surfaces of supersaturation or the hydraulic gradients were so far lowered in the levees themselves that they were successfully completed in the face of the flood.

The subsurface drainage of fine sand or quicksand, and other porous material interstratified with stiff or impermeable material, is a well known efficient remedy for back caving or sloughing of banks. I believe it has been employed on the Mississippi to prevent destruction of revetments, due to caving produced by back flow through sand strata on falling stages; but the addition of banquettes on the land side of high levees, is the usual remedy on that river, applied to levees. The writer stopped slides in a steep bank 160 ft. high at Ft. Wadsworth, N. Y., at The Narrows, by subdrainage, and can cite many cases of stable embankments following proper drainage, which otherwise would have failed. Drains so constructed as to prevent actual motion of earth or sand by water carriage, but that will at once lower the water level by filtering into adequate conduits and thus reduce the hydrostatic pressure, and prevent the transmission beyond them of fluid pressure due to percolation under a head of water, are much more important and effective in securing stability of earth embankments, whenever applicable, than the location of borrow pits.

These methods of construction relating to drainage are widely used and inculcated, and are sometimes applied in principle in high masonry dams to relieve the horizontal joints of slowly accumulating hydrostatic pressure which would otherwise reduce the stability of the dam. In rock-fill dams the artificial reduction of the hydraulic grade line through gravel and earth blanket by the open interstices in the rock fill is universal. The method is in evidence in canal-bank construction wherever canals are in embankments or on side-hill cuts in sound earth; in agriculture in tile drainage; in reclaiming lands swamped under seepage from irrigation processes, and generally whenever it may be desirable and practicable to free earth from water.

There is a rule similar to the borrow-pit rule in its absolute character, based upon sound methods of insuring stability, and of greater value for large locks, i.e., that the floor of a canal lock shall be thick enough to sustain the entire hydrostatic pressure due to its depth below the upper level without break. This is general in nearly all textbooks.

The writer built 23 locks on the Hennepin Canal and others elsewhere, with very thin watertight floors incapable of resisting one-fourth of this pressure, the pressure being relieved by a simple system of subdrainage by porous pipe, which does not allow or produce motion of earth particles in even fine quicksand, but at once stops the accumulation of hydrostatic pressure due to slow percolation or infiltration, and lowers the hydraulic grade line.

The writer holds, economic requirements aside, that in earth-dam construction, including canal embankments, the best and most usual practice is to provide for impermeable material on the water side; efficient core or puddle walls to cut off underflow, and good drainage on the land or downstream side.

Levee engineers, on the contrary, do not hesitate to cut through an impermeable stratum into a permeable one on the water side; build a muck ditch "at least 2 ft. in depth" under the embankment, without further attempt to cut off the permeable path for underground flow, and then depend upon the defeat of the enemy, after he has passed these defenses, by friction in the porous path and by the passive resistance of an unbroken but perhaps supersaturated crust on the land side, even though want of money may not prevent better practice.

Mr. Sellew seems more daring. Not only does he cut his checkerboard borrow pits on the river side, giving by his own account more easy communication between the river and alleged ground water, but he also cuts an irrigating canal on the land side of his levee, again breaking the crust, and fails to explain wherein the effects of the latter will differ from those he attributes to land-side borrow pits within two miles of his work.

This last sentence refers to the most remarkable of all the failures obviously due to omission of the most ordinary precautions to secure stability, and which failure is attributed to land-side borrow pits: that of the levee built by the Southern Pacific Co., near Yuma, Ariz., under a head of 15 in. of water. This levee was built upon an unprepared foundation covered with vegetable trash and not even plowed, with no muck ditch or core wall, on land, I am informed, with drying cracks extending in every direction under and across the site of the levee, through which cracks water flowed in large quantity. There happened to be an unfortunate borrow pit or scapegoat in the rear, and the failure of the levee is attributed to that ditch.

There seem sufficient reasons for the failure of that levee, if not at 15 in. then at 17 in. or other small head, but both Mr. Sellew and Mr. Ockerson leave it to be inferred that, in their opinion, the borrow pits on the land side caused the failure of a levee that would otherwise have been stable. Opinions fortunately are not facts; a farmer once told me that bugs ate his vines down to earth, but that his potato crop failed because he had planted it when the moon was in the wrong phase, and I have heard of a case where a man was shot through the heart, and when falling cracked his skull; the one who shot him was acquitted of murder on the ground that the last injury killed him; it was a valuable opinion of the *post hoc propter hoc* variety, so conclusive in levee building.

If such free underground flow and high ground-water level exists there as is necessary to justify this opinion as to the causes of destruction of this levee, it is very difficult to understand why all the extremely fertile land in that vicinity has not long since been brought under cultivation by pumping from such free and shallow supply, unless, indeed, one can believe that nature has provided a stratum at just the level and porosity best adapted to destroy levees having land-side borrow pits, but of no useful avail—a devilish not godlike arrangement.

We have also seen in that vicinity an example of failure, where in the twinkling of an eye an important levee has been wiped out of useful existence by comparatively very little water following a well cleaned and nearly continuous line of water-side borrow pits of steep slope into which it had been deliberately diverted before the Colorado had reached near its bank full stage, and a number of engineers maintaining that this practice is not only correct, but should be continued, and even made obligatory in all cases because some failures have occurred elsewhere attributed to land-side borrow pits, but which may have been due to the activity of crayfish, gophers, or defects in core walls or drainage, and which could have been avoided or cured in many cases by timely application of processes usual in all other forms of earthwork than levee building. There were other things than borrow-pit location that would inevitably have caused the destruction of that levee—not so soon, perhaps, nor upon such insignificant attack; the root of all such causes of failure being the ambitious attempt to solve a problem, by means of very little money and inadequate constructions, which requires, under any durable and efficient plan, many times the amount then available, and much more time for study and planning, as well as for construction, than was available. If that failure results in calling attention to the requirements of this work, the money has been well spent, even if otherwise lost—a libation to truth. The failure of that levee can result in nothing but good; it certainly will advance the date of an international agreement and control on and of the waters of the Colorado. No property in the United States has been damaged or even seriously threatened; and it has been made evident that plans applicable in other streams are not necessarily or even probably applicable in the

Colorado, where different conditions exist; nor has it apparently hurt any individual in the engineering profession or elsewhere in the estimation of his fellows.

Without reference to the writers named, some of the borrow-pit experts seemingly believe, and some of them practically say, they consider it better to insure the destruction of a work by adherence to a specification than run the risk of having it said that one is ignorant of levee construction. Mr. Cory, although not one of those referred to, considers taking material from the land side of a levee as "heroic," even when he could not get it anywhere else. I think Mr. Cory more an engineer of sound judgment than a "hero." He practically confesses that he did not wish to be a hero, but the instinct of the engineer probably bore on him, compelled him to act correctly, even though the act were heroic; but he felt compelled to apologize and placate expert opinion. If he were also a good Presbysterian he would not apologize.

The construction of earth works is a large question. The proper drainage of them alone, as affecting stability, is a subject wide enough for a volume and the proper construction of levees, one of the class, is a much wider field of thought and care than the subject has been made, since they are subject to the same ills, and the same corresponding remedies as the important class of structures with which they belong.

The object in bringing forward this question was not to either attack or champion any practice, but to do what can be done by the writer to persuade engineers to apply study and reason instead of a specification to their work. It is very evident that there is danger that some engineers will add as an appendix to their decalogue and insist on others adopting it: "Thou shalt not dig a land-side borrow pit for levees, for we will not hold him guiltless who violates this law."

After reading what my friends think of the subject, it may cause them further surprise and regret over an old man's decadence, when it is herein asserted and maintained by him, that economic conditions govern levee construction in every respect: the location of the levee; the allowable location of the borrow pits; and the degree to which the usual methods to insure stability to earthen dams, are, or may be applied to levees. Physical laws and facts must be considered after, or in connection with, the economical.

Along American rivers, levees are built without efficient core or stop walls, reliance for stability being largely placed in the frictional resistance of the material to percolation between free surfaces on the water and land sides of the levees. Efficient drainage in the rear is also usually omitted, and the material is taken from the river side, all as a direct result of the low value and small acreage of the lands and property appurtenant thereto protected by the levees and the great extent of the lines of levee—not from ignorance of nor to comply with physical laws affecting stability of earthwork. Whenever the river channels become fixed in position, as they undoubtedly will be by making the banks safe against scour, the levees will be pushed forward to the edge of the channel, and river-side borrowing of material will cease; or as soon as the lands become so valuable as to justify revetting the banks of the river, this result will follow.

Witness New Orleans, the whole site of which lies from 4 to 15 or more feet below high flood level of the Mississippi River, which nearly encircles it. The levees are near the banks, and river-side borrow pits are nearly out of the question. Seep water and sewage are drained to the rear and discharged by gravity, aided by pumps, into Lake Ponchartrain; all excavations are on the land side, where ground water rises so high, that even the dead are buried above ground to avoid water.

Witness Holland, every acre of which is represented by a human being, and where land is so valuable that during hundreds of years vast sums of money have been used, and are still being used, in pushing dikes or levees out into the sea to inclose and reclaim lands lying below high water. A very large part of the entire kingdom lies with its surface below flood level, and all excavation, and cultivation, drains and ditches are on the land side of the levees. The lands are made arable and habitable by draining and pumping into canals with water surfaces at such level as to admit of discharge into the sea at suitable times.

It is useless to go further along these lines, but even in the narrow sense of this discussion it is susceptible of proof that any extensive excavations on either side of a levee not provided with core walls or drainage systems, and near the base of the levee, will diminish its stability. The levee will be most stable if there be no break on either side.

River-side borrowing is nearly universal along American rivers, under existing economical conditions, because it pays to so waste land. This practice has probably diminished the stability of newly built levees to zero, or contributed to that result, in 90 per cent. or more of the cases where levees of normal cross-section, but without banquettes, have been lost without being overtopped by water. In such cases the losses have been due to the cutting away of the natural earth crust near the levee; the presenting of a fresh clear filtering surface to percolation, combined with a shortening of the paths of water percolating under the levee from water to land side of the levee, or flowing through crawfish or other holes. This fact is not susceptible of direct proof, but there has been a very material diminution in the number of crevasses in newly built levees since the paths of percolating waters have been increased by banquettes in the rear.

It is quite probable that many failures attributed to land-side borrow pits have been due to cuts on both the land and river sides at the same flood stage, each diminishing the stability of the levee. This is said because the taking of material from the land side occurs usually, or at least frequently, after the rising flood has driven the laborers out of the river-side borrow pits, and after the levee has in great part been built up. The bearing of this fact on stability is obvious.

But wherever and whenever values of land become so great for sites of valuable buildings, or for intensive cultivation, that it no longer pays to waste it for borrow pits—whenever it pays to revet river banks, and to reclaim to the edge of the channels or even further, then the inexorable and automatic laws of economy will do away with river-side borrow pits as well as other practices inconsistent therewith, and end this discussion, in so far as that vicinity may be concerned in it.

The writer is not an advocate of any practice other than that the best, most stable, and most advantageous construction and methods of construction to attain the object, and that are consistent with economy, shall be followed, but he desires as far as his influence can extend, or be extended, to free the profession of civil engineering from procrustean practice.

Crawfish and muskrat holes, streaks of porous material, concealed windrows of sticks and leaves, are accidents, incidental to extensive earthwork dams, and must be dealt with when encountered, but are not of sufficient importance to justify the cost of efficient continuous core walls in levees. It is a question, in so far as the stability of levees is concerned, whether it is a greater risk to cut through and thus "open up" such tubes by river-side borrowing, thus shortening the paths of flow under the levee, or to cut into them at the prescribed distance in the rear of the levee.

There is no doubt in the writer's mind as to which practice is most dangerous to levees along muddy rivers, where filtering of muddy water speedily clogs small interstices, and deposits of mud soon fill in solid all tubes of considerable length, on reduction of head; this action being nearest the river bank. Such accidental circumstances as crawfish holes have never deterred engineers from locating either extensive levee lines, or borrow pits, where considerations of economy, only, indicated.

Wm. L. Marshall,
Brig. Gen., U. S. A., Retd.
Washington, D. C., Feb. 19, 1912.

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Engineering News

General Instructions to Bidders on Contracts for Public Work

The large amount of space taken in this issue by Mr. Cochran's article on "Instructions to Bidders on Contracts for Public Work" may seem to some of our readers to need comment, though to the majority we are sure no explanation is needed.

All engineers who have had anything to do with the preparation of specifications to accompany calls for bids on public work, whether of a small 500-hp. power station or a 10-mile section of city subway, will recognize the value of a standard by which they can test the completeness of their general instructions. We know that in some cases it has been necessary to rely on the experience and mental alertness of the engineering staff in detecting omissions. In many cases, perhaps in most, the more certain, but more laborious process, has been used of going through several specifications which have served acceptably in other situations more or less like the one in hand to see if in the one about to be issued there are dangerous or annoying omissions.

If one would compile the general clauses of a great number of acceptable specifications, reduce them to a common form of expression and classify them in an orderly manner, he would have much the same sort of a standard that Mr. Cochran has worked out and presented in the article reprinted elsewhere. Indeed, such a process has been followed in this case and the article represents much such effort spread over several years. Many persons have examined the standard and indeed have practically tested it, but only slight additions have been made to it since it was put in its present form.

This article is not exciting; perhaps it is not even inspiring reading, but it should prove to be a valuable tool to the engineering profession as a means of more closely safe-guarding bids on contracts and eliminating costly misunderstandings. As such, it surely deserves all the space we have allotted to it.

The Mud Nuisance on Oiled Macadam Roads

With the coming of spring and summer, municipal engineers have brought again before them the perplexing question which has been giving many of them grey hairs for several seasons past: "What shall we do this season to cope with the dust nuisance on macadamized streets?"

Probably the most generally adopted plan has been the sprinkling of the macadam with some asphaltic oil. It has been demonstrated that, where horse-drawn traffic does not predominate, such sprinkling is a success in preventing disintegration and undue wear, by building up a rubbery traffic mat on top of the stone.

But in escaping from the chorus of complaints of the dust nuisance, the engineer runs foul of a new set of protests from indignant citizens who find carriage varnish, clothing and floor coverings ruined by the black, greasy mud which covers these roads after every hard rain.

The cause of this nuisance has been variously explained, but the condition has seldom been remedied. It has now been shown that asphaltic oils and water will form an emulsion whenever colloidal matter like clay is added. This is what happens to the asphalt-bound traffic mat under the soaking of rain and the kneading of traffic. Considerable loam and litter are carried onto the road in the course of ordinary traffic, and the rain and wheels complete the process. After the rain has ceased, the emulsion gradually dries out and the traffic mat eventually becomes as effective as before, but it is again converted to mud by the next heavy storm. When the mat contains a large proportion of bitumen and is dense and rubbery, this emulsifying is delayed—but only delayed. When the mat grows older and so much dirt and litter have been ground into it that the proportion of bitumen is lowered, then its earlier water-shedding qualities are lost and its surface is slimy, slippery and nasty after every shower.

Several remedies are conceivable, but practical objections arise to all of them. For instance, before applying the binder, great care must be paid to removing the last traces of fine dust and litter and in throwing on gravel, small stone or screenings as a filler—the finest dust is to be discarded. Moreover, this filler must be of a material not easily reduced to an impalpable powder under traffic. Every means must be taken to prevent the carriage of dirt and litter onto the traffic mat, as by providing frequently cleaned approaches. The unavoidable accumulations of dirt and litter must be removed before each storm. More oil should perhaps be added from time to time during the season to keep the bitumen percentage high and the water-shedding qualities of the mat unimpaired. The expense involved in these measures is obvious.

So impractical, therefore, seem all the present expedients for preventing this greasy mud that the trouble seems like a

necessary wet-weather evil of oiled macadam.

In our issue of Feb. 29 we commented on the proposal of the New York State Highway Commission to build a "good road" at low cost by mixing "bituminous materials" with an ordinary road dirt. But if the dirt-oil mixture in wet weather approaches a nuisance where stone foundations support the wheels which sink through the mud, what will happen where the whole road is composed of emulsion?

The New York Highway Commission announces that it proposes to give "thorough trials" to this plan of cheap road construction. Perhaps it may incidentally cause "thorough trials" to the residents along the line of these experimental roads.

It may be worth notice in this connection, apropos of the claim that the projected "bituminous-dirt" road is to be a low-cost road, that in one southern California county which built a very large mileage of these oiled dirt roads several years ago the average cost was about $13,000 per mile, notwithstanding the proximity to the oil fields.

Indicated and Actual Wind Velocities

Our reference in last week's issue to the remarkable wind velocity reported by the Weather Bureau for New York City, on Feb. 22, namely 120 miles per hour for a period of one minute, requires a further word.

The formula for the Robinson anemometer was quoted as:

$$\log V = 0.509 + 0.9012 \log v,$$

in which V = actual wind velocity, miles per hour; v = velocity of cup centers, miles per hour; and logarithms are taken to base 10. Contrary to our statement, our estimate of 90 miles per hour actual velocity was not made by this formula, but by plotting a table published in the Weather Bureau bulletin "Anemometry," which table covers a range of indicated velocities from 5 to 90 miles per hour. We extended the curve thus obtained to 120 miles per hour, and thus found a value for the corresponding actual velocity, viz., 90 miles per hour.

The formula, however, gives the same result, and indeed the table was computed from the formula quoted. In applying it, the following fact is to be taken into account, stated in a letter by Prof. C. F. Marvin, of the Weather Bureau:

> The construction of the anemometer is such that v, the velocity of the centers of the cups in miles per hour, is always one-third the indicated wind velocity in miles per hour.

In other words, what the Weather Bureau records and publishes is a figure representing *three times the anemometer velocity.*

Changing the formula to use directly the reported velocity, and calling this latter A, we would get

$$\log V = 0.079 + 0.9012 \log A$$

which is equivalent to

$$V = 1.2\, A^{0.9012}$$

although, of course, the first form would be used for computations.

The text of the bulletin mentioned states that the formula was derived from experiments made by mounting a standard Robinson cup anemometer on the end of a whirling arm and noting the revolutions of the anemometer. That such rating presents an interesting testing problem will be recognized by those familiar with the methods employed in other rating problems. It would appear inevitable that the result should be affected by large uncertainties, and that when a formula informs us that a recorded velocity of 20 miles per hour represents an actual velocity of 90, we should consider that the figure 90 is an indeterminate something between 75 and 100 (or possibly wider limits).

As a matter of fact, the Weather Bureau does not regard the formula as accurate for high velocities. Prof. Marvin's letter says:

> The formula is based on actual tests, but only for indicated wind velocities up to about 60 miles per hour. For higher velocities, and extreme conditions up to 90 miles per hour, the exact relations have never been entirely established, owing to the inherent difficulties attending investigations of this character. While the values given in the table are the best we know at the present time, special accuracy is not claimed above 50 or 60 miles per hour.

The question of the accuracy of the formula, however, is of less concern to the public than to the Weather Bureau. The public which uses the Weather Bureau figures should not be expected to make reductions of instrumental figures. We find it difficult to understand why the Weather Bureau should record and publish in all its reports *only the anemometer records and not the true wind velocities.* Rather, we may make the point stronger. Why should the Weather Bureau publish the anemometer records at all when, by its own table, these records do not represent true wind velocities, but are in every important case 20 to 30% in excess?

A mere instrumental record is of no importance to the public. The engineer particularly is concerned with wind-velocity information only when it furnishes him correct figures. A fictitious record may be seriously misleading. Yet, not only do the daily reports of the Weather Bureau on wind velocity give these fictitious figures, but the whole accumulated records of the Bureau represent—so far as wind velocities are concerned—only a mass of instrumental values which have no fixed relation to actual velocities. The Bureau publishes and records an artificial figure equal to three times the anemometer speed, and the only merit of this figure is that it is within 20 to 30% of the wind velocity. Is it not time that this system were changed?

Sound and Unsound Ideas of Municipal Engineering Adminstration

A surprising mixture of sound and unsound ideas as to municipal engineering administration is given in the February *Journal of the Engineer's Club of Baltimore* in an article by Charles D. Sudler. In discussing the proposed new charter for Baltimore, Mr. Sudler calls attention to the fact that 11 municipal departments of Baltimore, having to do with engineering and public work, have a combined appropriation for the year 1912, of $14,086,000. In view of the fact that the work of these departments overlaps, in many particulars, and thus gives rise to considerable conflict and inefficiency, Mr. Sudler very wisely suggests that coöperation and efficiency might be brought about by "centralizing the executive work of them all under one chief engineer." He also suggests that numerous unpaid boards now in charge of municipal work at Baltimore be abolished. In support of this suggestion, he says that "there are very few men who can afford to donate enough of their time to properly study the questions coming before these boards; and also that such boards are usually made up of men unfamiliar with the technical work of their department."

Thus far we believe the engineering profession will agree with Mr. Sudler, but we think it will almost to a man disapprove Mr. Sudler's proposal that the chief engineer of a city should be elected by popular vote, should be responsible to the people only, be necessarily a registered voter of the city and a resident of the city for at least two years prior to the time of his election.

The underlying principles of other requirements for candidates for the position of chief engineer seem to be both reasonable and desirable. These include the proposed provision that the chief engineer should hold office for not less than four years, that he should have been actively engaged in the practice of engineering for at least 15 years, or in lieu of this a graduate of some engineering college of standing and in active practice for at least 12 years; and that in any event he "should have been in responsible charge of engineering work for at least eight years."

It is only fair to Mr. Sudler to say that he has reasons, whatever one may think of their validity or strength, for the ground which he takes in regard to having the office of chief engineer filled by election. We quote as follows:

> The above is not offered as an ideal solution of the very serious problem of securing the best qualified man for a responsible position, for the reason that in the engineering field especially, the best man is often the poorest politician, and an engineer of very meager ability

if he be a good "mixer" and experienced in self-advertising, might perhaps win over a man with much better qualifications. If the city's chief executive were always a broad-minded man of the highest principles—one who looked always to the city's best interests—it would be well enough to have the position appointive; but having it so, and with the present clause permitting the mayor to remove a department head within six months without charges, it becomes a most powerful weapon, which might be wielded for the mayor's personal or political ends regardless of the public will. Through this position the mayor could practically control all the subdepartments with their thousand or more employees, making the chief engineer a mere tool or figurehead.

With the position an elective one, however, the nominees would have to come before the public where they would be subject to searching criticism, and where the press would discover their qualifications—good or bad. Their records would be opened for those who cared to read, and even after the election the winner would feel his responsibility to his constituents. Moreover, it is unlikely that any engineer who was elected to a position of such honor and responsibility would destroy his reputation by abusing it.

Some of these reasons have force, but not sufficient force to support Mr. Sudler's thesis. The last of the two quoted paragraphs strikes us as being particularly weak in its arguments. The mass of the voting public, quite regardless of ignorance or knowledge, poverty or wealth, is absolutely unqualified to select men to fill technical positions. Intelligent selection of such men can only be done by the exercise of individual judgment. A technical officer does not come within the rule that the people should choose their representatives. Under representative government, representatives are elected to determine principles and general courses of action and the amount of money which shall be devoted to their execution. They are not chosen to perform specific tasks, but merely to decide what tasks shall be performed and who shall perform them, and to pass judgment upon the efficiency which is shown by the chosen servants in carrying out the tasks.

As we remarked in these columns a few months ago, it would be as sensible for the thousands of stockholders of the Pennsylvania R.R. to cast their ballots for the election of the company's chief engineer and its superintendent of motive power as it is for the voters of a city to select by ballot the city engineer and the superintendent of the water department.

We trust that the engineers of Baltimore will make it known to those responsible for the drafting of the proposed new charter that the ideas expressed by Mr. Sudler in regard to the election of a chief engineer are not those of the engineering profession, or even of a respectable minority thereof.

The Increase in Public Debt

One of the most dangerous fallacies current at the present time in connection with municipal affairs is that the public debt of a city consists merely of the bonds and other indebtedness which the city is obliged to pay, and that the cost of public utilities which are owned by companies operating under franchises forms no part of the public debt. Admittedly this is true as a matter of bookkeeping, and true also as a matter of financial obligation; but so long as the public utilities in a city continue solvent and in operation, the actual burden upon the city's taxpayers and residents of supporting these public utilities has to be borne just the same whether they are owned by the city or by a private company.

A good illustration of this fallacy is before us in the shape of an order issued by Samuel G. Dixon, Health Commissioner of Pennsylvania, to the Borough of Coatesville. This order requires the Borough Council of Coatesville to have prepared and submit plans prior to a certain date for the purification of the borough's sewage before discharging it into Brandywine Creek. The Health Commissioner also ordered the Borough to take immediate steps for the radical improvement of its water-supply system, in view of a typhoid epidemic which appeared in the town early in the present year. Coatesville now has upon it a debt of $150,000. Its assessed valuation is $5,000,000 and the statutory debt limit is 7% of the valuation. Therefore it can borrow $200,000 additional before reaching its debt limit. But it is probable that the improvement of its water supply and a system of sewage treatment will cost considerably more than $200,000, and the Health Commissioner recommends a way out of this difficulty as follows:

> This need not deter the town from proceeding to treat its sewage, for it is competent for the local authorities, in event of the borrowing capacity proving too small for both purposes, to contract with a private corporation to erect and operate a sewage disposal works, the borough paying an annual charge for the benefits derived.

This may be a perfectly legal way of "whipping the devil around a stump," or in other words enabling the community to contract an indebtedness in excess of the legal limit; but it is evident that neither the city nor its taxpayers will be any better off than they would be if the work were done by the municipality. The city will have to pay the interest on the cost of the sewage-disposal plant just the same, but it will be paid in the form of rental to the company (plus a percentage for profit) instead of interest on city bonds. The charge in either case is a direct obligation of the municipality and will have to be paid from the proceeds of taxation. Further, if there is any question as to the ability of the city to continuously pay this rental, then an element of risk will be involved in the company which undertakes to treat the borough's sewage, which risk will have to be paid for by a higher rate of interest on the bonds or stocks which the company issues to raise money for the work. The net result, therefore, of this policy, recommended by Commissioner Dixon, is that the city and its taxpayers will have to pay in the long run a larger price for the sewage-disposal plant if built by a private company than they would if it were built by the municipality.

We have taken the Coatesville sewage-disposal plant as an illustration, but the same principle holds good for all the public-utility companies which are operating in our cities. The real public debt of a municipality, on which interest must be paid by its taxpayers and residents, is not merely the bonds and other promises to pay issued by the city government. It includes the total obligations of the franchise corporations which furnish the city with water, gas, light, street transportation and similar facilities necessary for the city's daily life and commerce. How little this principle is understood is also illustrated by the long discussion in New York as to whether extensions of the underground rapid-transit system shall be built with "city capital" or "private capital." These terms are used as if they really meant something; as if the city had capital of its own to invest which it could expend in the building of street railways. The fact is strangely overlooked that the city must use private capital in any event. The money will be borrowed from the public by the sale of bonds in either case. If the new lines are built and owned by the city, then the city itself will see to the payment of these bonds, interest and principal, using for this money revenues received from the rental of the line when constructed. If the road is built by a company, bonds will be sold to the public just the same and will bear on their face the name of the operating company instead of the city. This company will likewise take the revenue received from passenger fares to pay the interest on the bonds and the principal as they fall due.

It will be said, of course, that in case a public utility becomes insolvent so that its revenue is insufficient to pay its fixed charges, the city taxpayers will be in a much better situation if the bonds which have been issued to pay for the utility are issued by a franchise company than if they are a direct obligation of the city. Manifestly the city ought not to undertake any public utilities which are experimental or of doubtful financial success; but how much risk is there today in the operation of established public utilities? A little study shows that the element of financial risk in the operation of public utilities has been largely removed by

present statutes and court decisions which establish the right of a franchise corporation operating a public utility to charge such rates as will return a reasonable rate of interest on the money actually invested. Such a reasonable interest rate, moreover, will always be higher than the rate at which a city of unquestionable solvency can borrow money itself. Under these circumstances, therefore, the element of risk in a franchise company's investment in public utilities is practically eliminated.

As we stated above, however, if the element of risk is removed from operation of these public utilities, the burden of paying for them must be borne by the community just the same whether they are owned by the city or by a private company, and a profit must be paid to the company besides.

The question of municipal ownership of public utilities deserves to be debated on its merits, therefore, and not obscured by fallacies respecting the volume of city debt. Further, where public utilities are turned over to franchise companies for construction and operation, it is important to the public and the taxpayers that the work shall be done with honesty and economy, and that the volume of bonds and stocks issued to pay for it shall be as small as possible.

In view of the above facts it may well be asked whether the statutory limitations upon the bonded debt a city may incur should not be raised? It is certainly true in many cities that the necessities of present-day municipal administration seem to require this.

It is not to be forgotten, however, that this limit on municipal indebtedness has been fixed to serve as a protection against municipal bankruptcy and the saddling of undue burdens upon taxpayers and property owners. It must be regretfully admitted that in many cases the debt limit provides a necessary check on the corruption and extravagance of municipal governments.

What most of our cities need to do is to turn themselves energetically to the task of paying off old debts contracted by former corrupt or inefficient administrations, thereby freeing themselves to assume the burden of the new debts required to meet present-day conditions. In our municipal, as well as our state and national finance, we have had altogether too much building on borrowed money. Unloading the burden of paying for the things which we happen to desire upon a future generation has been too popular.

One reason for the high cost of living in all our cities at the present day is the heavy public debt which was shouldered onto the present generation by those who lived 20 or 40 years ago. There are hundreds of millions of outstanding state, municipal and public-utility bonds and other securities, on which interest is now being paid by the city dwellers of the present day, notwithstanding the fact that the actual work or materials or construction for which the bonds were issued long ago became obsolete or went to the scrap heap. If we, of the present day, do not adopt a wiser and more farsighted policy, the generation that comes after us will have to struggle under a burden of public debt so heavy that it will constitute a menace to the whole system of private property and property rights.

It is for such reasons as these that we strongly dissent from the proposition that the statutory debt limit should be made an excuse for turning over to a private corporation the control and management of such a necessary piece of municipal machinery as a sewage-disposal works. It were better by far to raise the statutory debt limit and allow the city to construct such a necessary public utility with its own funds.

It will doubtless be wise and necessary to permit cities to invest in many classes of self-supporting and profitable public utilities without including the obligations therefor in the statutory debt limits, and in many cases this has been done. A better policy still, however, is to economize in public expenditures, to cut down outlays for improvements which are luxuries rather than necessities and so far as possible to pay for necessary public improvements by direct taxation rather than by increasing the burden of public debt.

The Average Life and Cost of Maintenance of Freight Cars

The accompanying table is reprinted from the Feb. 10 issue of the *Railway and Engineering Review*, which credits it to a Mechanical Engineer of one of the railway companies mentioned.

The average age of all freight cars in service, according to these figures, is a little less than 10 years; omitting destruction by wrecks the average life is lengthened to 21.24 years. During its life each car is repaired on an average of once a month, at an average cost of $6.26 each time. During its life each car, therefore, requires a total expenditure for repairs of about $1600, or twice the first cost of the car.

Inspection of a Deep Well was made recently at Galva, Ill., by means of electric lights and a field glass. A well 1400 ft. deep was found to be delivering water of bad quality. The superintendent of the water-works had the pump pulled out, connected three electric lights in a cluster and lowered them slowly into the well. With a field glass the well casing was carefully inspected. At 110 ft. from the surface, where the casing is reduced from 12 in. to 9 in. diameter, it was seen that the packing was loose and ground water was entering.

FREIGHT CARS, AGE, MILEAGE AND REPAIRS

Years Ending June 30, 1911–1910–1909

Road	Year	No. of cars owned	Average Age: All cars	Average Age: Cars dismantled	Average mileage per car per year	Cost of actual repairs: Average per car	Cost of actual repairs: Average per car mile	Average times car repaired	Average cost per time repaired
C. B. & Q.	1911	52,577	9.1 yr.	22.0 yr.	11,650	$59.16	0.508c.	10.1	$5.86
	1910	51,603	10.0 "	22.0 "	12,347	70.33	0.570c.	10.6	6.64
	1909	50,185	10.4 "	22.0 "	11,272	64.85	0.575c.	10.4	6.21
C. & N. Ry.	1911	62,000	9.11 "	22.25 "	8,527	47.90	0.561c.	13.4	3.62
	1910	68,869	9.00 "	20.9 "	8,275	42.30	0.511c.	12.8	3.29
	1909	59,623	9.3 "	20.2 "	8,150	39.56	0.485c.	10.7	3.72
C. R. I. & P.	1911	43,166	7.7 "	22.2 "	10,930	74.77	0.67 c.	17.8	4.20
	1910	41,119	8.0 "	22.1 "	10,812	75.65	0.67 c.	16.1	4.53
	1909	39,097	8.0 "	20.0 "	10,125	64.85	0.640c.	14.7	4.41
Colo. & So.	1911	8,471	8.37 "	21.6 "	5,982	67.10	1.10 c.	7.1	9.45
	1910	7,101	7.85 "	21.55 "	8,019	94.54	1.179c.	10.2	9.27
	1909	7,155	8.5 "	21.2 "	6,455	99.93	1.548c.	7.1	14.16
G. N. Ry.	1911	46,630	10.75 "	25.04 "	8,012	40.62	0.507c.	10.3	3.96
	1910	44,833	10.13 "	17.44 "	8,731	43.16	0.49 c.	10.3	4.21
	1909	42,858	10.0 "	14.0 "	7,867	35.97	0.432c.	4.4	7.65
Wabash	1911	23,083	11.5 "	19.7 "	14,266	71.44	0.50 c.	18.5	3.86
	1910	21,694	.....	21.7 "	12,604	65.21	0.517c.	15.6	4.17
	1909	23,190	.....	19.5 "	11,218	53.01	0.473c.	13.7	3.88
C. M. & St. P	1911	48,539	*12.96 "	*21.0 "	11,012	68.22	0.619c.	9.2	7.4
	1910	49,179	*13.57 "	*0.79 "	10,645	61.33	0.576c.	9.0	7.76
	1909	57,550	10.7 "	20.3 "	9,559	50.62	0.529c.	7.3	6.9$\frac{1}{4}$
N. P. Ry.	1911	43,100	9.9 "	23.6 "	8,028	53.46	0.66 c.	13.8	3.86
	1910	43,813	9.2 "	23.2 "	9,036	56.60	0.62 c.	11.8	4.78
	1909	41,498	9.4 "	20.9 "	9,083	41.77	3.460c.	10.5	5.85
Ill. Cent.	1911	60,824	9.1 "	21.7 "	10,142	91.99	0.907c.	11.16	8.07
	1910	62,705	8.4 "	15.1 "	9,461	134.01	1 417c.	11.01	11 65
	1909	63,622	7.6 "	14.7 "	8,855	104.71	1.182c.	10.1	10 46
A. T. & S. F.	1911	63,455	10.6 "	26.0 "	10,724	61.53	0.574c.		
	1910	57,746	11.25 "	26.0 "	12,143	81.24	0.669c.	16.1	5 03
	1909	54,698	11.0 "	27.6 "	10,840	90.72	0.837c.	13.9	6.50
U. P. Ry.	1911							Figures	Figures
	1910	14,863	9.2 "	21.3 "	19,987	100.83	0.505c.	not given	not given
	1909	14,954	10.0 "		18,659	102.98	0.552c.		
Average.		Abont 10 yr.		21.24 yr.		1911,	0.6606c.	About 12	$6.26
						1910,	0.7021c.	times per yr.	each
						1909,	0.7011c.	(once a month)	time

*Includes Puget Sound Extension, C. M. & P. S. Ry.

Lessons from Recent Coal Mine Disasters*

By Joseph A. Holmes†

It would be unfortunate as well as unpardonable if from the many American mine disasters of the past few years we had not learned some lessons that may help to prevent or minimize future disasters or reduce the loss of life resulting from them. I shall endeavor to call attention to a few of these lessons that stand out most prominently.

First of all, attention may be called to the fact that we are not making satisfactory progress in reducing the loss of life in our mines; and we will never make this progress until we get away from the theory and get down to actual practice and develop that hearty determined cooperation between the mine owner and the mine worker, which is absolutely essential to success.

Of the fatalities in coal mines during 1910, 47% were from falls of roof and coal, 16% from mine cars, 18% from mine explosions, 4% from explosives, and 2½% from electricity.

Of the total fatalities, 90 per cent. were under ground, 10 per cent. above ground.

Mine Fires—Mine disasters have resulted from mine fires, gas explosions, or dust explosions, or a combination of two or all of them. The two most notable recent disasters from mine fires were the Cherry disaster of Nov. 13, 1909, where 259 men lost their lives—the fires having started from the burning of hay in the mine stable—and the Pancoast mine disaster, near Scranton, where 72 men lost their lives from a fire which appears to have started from the inflammable material at one of the underground power stations. In neither of these two disasters does there appear to have been any gas or dust explosion. It is evident that the men were suffocated or poisoned by the gases generated from the fire, excepting, of course, the few who were killed from the heat of the fire itself.

The two most important things taught by these two disasters were the risk that always attends the practice of carrying inflammable materials into our mines, and the inadequacy of present methods and equipment for fighting and extinguishing mine fires.

Of course we must have timber in the mine, and no economical method is now known for fireproofing this timber. As long as we keep mules in the mines, certain materials must be carried into the mines with which to feed them; but if baled hay must be taken into the mines for feeding purposes, it can be easily and superficially wet either by sprinkling or dipping it quickly into a tank of water and it can be carried in closed cars. By all means the easiest way to prevent the risk of fires in mine stables is to keep these stables outside of the mine.

Mine Explosions—In the gas explosions of the anthracite regions, I have no evidence that the dust has in any case become involved in the explosion, though I have no doubt that much of the finer dust is partly consumed in the burning of the gas of the explosion and thereby increases the quantity of poisonous gases generated in the mine. In a number of gas explosions in the soft-coal mines that I have examined it is evident that coal dust took part in the explosion itself. In other words, there was a joint explosion of the gas and the dust.

In several mine explosions in the soft-coal region where the larger part of the mine was wet either from fresh, heavy sprinkling or from natural seepage, it has been evident that the explosion was limited to a small portion of the mine where the gas was present in sufficient quantity, that the dust took part only to a limited extent in that immediate vicinity, and that the explosion did not extend to other portions of the mine because of the fact that the mine dust elsewhere was wet. In several other mine explosions which I have examined, where the mine was thoroughly dry and dusty and where there was no evidence to show that gas was present either before or subsequently, I have been convinced that the explosion was a dust explosion pure and simple, having been neither started nor propagated by gas.

Whether the original explosion was due to gas or to dust, or to the two combined, in many cases mine fires have resulted from the explosion and the continuance of these mine fires has, in several recorded cases, been the cause of a second or third explosion, due to the generation of gas and the subsequent admission of air in an attempt to reopen and ventilate the mine. In these second and third explosions, occurring in succession, it is more than probable in the soft-coal districts that both the gas and the dust have been involved each time.

The lessons taught in the recent study of dust explosions, both in connection with mine disasters and special experiments, are that the dust from practically all of the bituminous coals will explode under favorable conditions without any gas being present. They have also shown that a small gas explosion is one of the easiest ways of starting a dust explosion. In quite a number of mines, the danger from gas has been reduced by an extension of the entries far in advance of ordinary working operations, and taking the gas from these advanced entries out of the mine through special exits, so as to get rid of a large portion of the gas from the coal in advance of the ordinary mining work without overloading with it the ordinary return air currents.

One of the important lessons taught by certain recent mine explosions is that coal dust while thoroughly wet will not explode, but that with modern ventilation, and especially during cold weather, wet coal dust often becomes dry and dangerous within a few hours. Therefore the sprinkling of coal dust once a month or once a week gives us safer conditions for only a few hours immediately following the sprinkling. Indeed sprinkling "occasionally" is often a useless and even a dangerous practice, as it often tends to make us less careful in dealing with this half-dry or dry coal dust between the periods of sprinkling, and it never reaches the gob piles or other unused parts of the mine.

Wetting the coal dust through the introduction of steam along with the air current is by all means the most effective and cheapest way of moistening the coal dust during the cold weather. This steam warms the inflowing air and saturates it with moisture, which moisture is in turn deposited on and wets the coal dust in all parts of the mine reached by the air. This method continues through the winter season the natural "sweating" process which keeps the dust wet and helps to prevent dust explosions during the summer season.

As far as possible we should keep the coal dust out of the mine. And what we cannot remove we should keep wet either by liberal, frequent sprinkling or by turning exhaust steam into the mine, or keeping the dust mixed with fine soil dust, ashes or stone dust.

The influence of stone dust in preventing or checking coal-dust explosions is being carefully considered in France and other European countries; and in many mines the stone dust is considered more effective than water. In this country the stone dust has not passed beyond the experimental stage. But it is worthy of serious consideration and a thorough trial. Many of our mines have no steam plant near enough to be effective. And in many places the water supply is so limited that even occasional sprinkling is out of the question. In all such cases, if the use of stone dust can be made effective, the solution of this problem will be much simplified.

Good ventilation and the proper use of permissible explosives and safety lamps, and proper precautions in the use of electricity, all tend to prevent gas explosions. These precautions together with the use of steam, water or stone dust tend to prevent coal-dust explosions; and the tendency of these modern precautions is to localize the explosions which they may not altogether prevent.

*From an address given Feb. 13 before the Southern Appalachian Coal Operators Association.

†Director, U. S. Bureau of Mines.

Double-Tracking the Simplon tunnel is to be undertaken by the Federal Railways of Switzerland, according to "The Engineer," of London. The work involves extensive widening of the tunnel through different formations of decomposed mica schist or slate clay.

Location of Frog Points on Crandall's Transition Curves

By Anders Bull*

In track alignment, when the conditions render it necessary to arrange a turnout so that the frog comes within the limits of a Crandall's transition curve (a proposition often dealt with in subway work), extended computations are usually required before the frog point is located. Since the equations of the curve give no simple relation between the coördinates x and y, the problem admits of no direct solution, and the frog point is generally located by interpolating between the values found by a series of trial solutions; this is a time-wasting and tiresome work when great accuracy is required.

In the present article the author will give a formula which will greatly simplify the location of the frog point in such cases. Through this formula the location assumed for a trial solution may be corrected by means of the results obtained, and since each successive trial will thus give the location with an increased degree of accuracy the computer will not, as is more or less the case at present, be working at random, but will have all the advantages of a direct solution.

The equations of the transition curve in rectangular coördinates are:

$$x = l - lE; \qquad y = lC,$$

where l is the distance of point x, y, from the origin, measured along the curve; E and C are functions of ϕ, the slope angle of the curve in point x, y; and ϕ is itself a function of l, namely

$$\phi = \frac{l^2}{L^2} I \qquad (1)$$

the quantity I being determined by the total length of L of the transition and the radius R of the circular curve adjoining it. The values of E and C are given in tables, the use of which is assumed to be familiar to the reader.

During the following discussion the coordinates of the switch point (which may be located anywhere along the center-line of track) will be denoted by x_1, y_1, and those of the frog point by x_2, y_2. Similarly quantities related to the two points will be marked by the subscripts "$_1$" or "$_2$" for the purpose of distinction.

The point x_1, y_1 and the frog angle f are supposed to be given. From x_1, y_1 the value of ϕ_1, i.e., the slope angle of the curve in point x_1, y_1, may be computed.

In order to locate the frog point, a value is first assumed for l_2, and from this the corresponding quantities ϕ_2, E_2, C_2, x_2, y_2 are computed. In the case represented by Fig. 1 we then have the following relations, in which g stands for the standard gage (4.708 ft.):

$$AS = y_2 - y_1 + \frac{g}{2}\cos\phi_1 + \frac{g}{2}\cos\phi_2$$

$$AF = x_2 - x_1 - \frac{g}{2}\sin\phi_1 - \frac{g}{2}\sin\phi_2$$

or, denoting the quantities

$$g\,\frac{\cos\phi_1 + \cos\phi_2}{2} \text{ and } g\,\frac{\sin\phi_1 + \sin\phi_2}{2}$$

by G_2 and g_2, respectively:

$$AS = y_2 - y_1 + G_2;$$
$$AF = x_2 - x_1 - g_2. \qquad (2)$$

Further:

$$\tan\alpha = \frac{AS}{AF} = \frac{y_2 - y_1 + G_2}{x_2 - x_1 - g_2} \qquad (3)$$

from which the value of α may be determined.

Since the point D is the center of the turnout, the triangle DFS is isosceles, and since the angle formed between the outer rail of the turnout and the inner rail of the transition curve in point F is equal to the angles between the normals, we have:

$$f_2 = b - e = c - a,$$

or since

$$b = \frac{\pi}{2} + \alpha - \phi_2 \text{ and } c = \frac{\pi}{2} - \alpha + \phi_1$$

$$f_2 = 2\alpha - \phi_1 - \phi_2 \qquad (4)$$

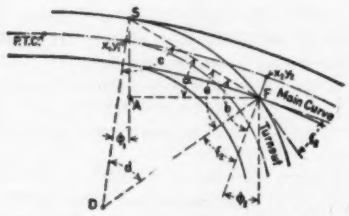


Fig. 1. Diagram of Turnout from Transition Curve

If the value obtained through equations (2), (3) and (4) for f_2 coincides with f, the value of the frog angle required, the frog point has been correctly located. Such will generally not be the case, however. Calling the difference between the two angles Δf_2, or: $f - f_2 = \Delta f_2$, then it is evident that the value first assumed for l_2 will have to be increased by a corresponding amount Δl_2 in order to give the correct angle between the rails, or: $l - l_2 = \Delta l_2$, where l is the unknown correct value of l_2.

There will be a relation between the two increments Δf_2 and Δl_2 which may be expressed as follows:

$$\Delta l_2 = \frac{\Delta f_2}{N} \qquad (5)$$

where N is an unknown quantity of either positive or negative sign. In the case represented by Fig. 1 the sign must be negative since increasing l_2 makes f_2 decrease.

If the exact value of N could be determined, equation (5) would represent the solution of the problem. While this is not feasible because of the character of the curve, N may be determined approximately and the value of l_2 thereby improved. By using the improved value, which we may call l'_2, for a new trial solution, rendering the correspondingly improved values ϕ'_2 and α', the angle f'_2 found by a second application of equation (4) will, if not sufficiently exact, prove to be considerably nearer the required value, f. Then N may be re-determined from the improved quantities, and the amount $\Delta l'_2$, by which l'_2 should be increased, found by a second application of equation (5). The value thus obtained, l''_2, will, as a rule, give satisfactory results.

An approximate value for N may be found by assuming Δf_2 and Δl_2 to be proportioned to the differentials df_2 and dl_2. From equations (5) and (4) we then have:

$$N = \frac{df_2}{dl_2} = \frac{2d\alpha - d\phi_2}{dl_2} \qquad (6)$$

The value of $d\phi_2$ is found by differentiating equation (1):

$$d\phi_2 = 2\,\frac{l_2}{L_2^2}\,I\,dl_2 = 2\,\frac{\phi_2}{l_2}\,dl_2 \qquad (7)$$

The value obtained for $d\alpha$, by differentiating equation (3), may be simplified by neglecting the differentials of G_2 and g_2:

$$d\alpha = \frac{AF\,dy_2 - AS\,dx_2}{(AF)^2}\cos^2\alpha \qquad (8)$$

Since the slope angle in point x_2, y_2 is ϕ_2, we have:

$$dy_2 = \sin\phi_2\,dl_2 \text{ and } dx_2 = \cos\phi_2\,dl_2. \qquad (9)$$

It will further be plain from Fig. 1 that:

$$\frac{\cos^2\alpha}{(AF)^2} = \frac{1}{(SF)^2} = \frac{1}{(AF)^2 + (AS)^2} \qquad (10)$$

Combining equations (8), (9) and (10) we get the value of $d\alpha$ in circular measure. Since, however, the angles are conveniently expressed in degrees, $d\alpha$ is reduced by multiplying by $\frac{360}{2\pi}$, or 57.3. Substituting the values of $d\alpha$ and $d\phi_2$ in equation (6), we have:

$$N = 114.6\,\frac{AF\sin\phi_2 - AS\cos\phi_2}{(AF)^2 + (AS)^2} - 2\,\frac{\phi_2}{l_2} \qquad (11)$$

All the quantities on the right side having been previously computed, N is found by a simple calculation for which the slide-rule may be used to advantage.

The above formula for N applies only to turnouts run on the inside of transition curves and having a direction as indicated in Fig. 1. For other positions of the turnout the signs of the terms will change. In Fig. 2 the several conditions met with are tabulated in a form convenient for reference, the value of N and of the quantities governing it being given for each case.

The use of this table will be demonstrated by the following example:

Given a transition curve 150 ft. long to a circular curve of 500 ft. radius. A turnout is run on the outside of the main curve using a No. 7 frog. The switch point is located on the transition curve,

*Designer, Public Service Commission of First District, 154 Nassau St., New York City.

between the frog point and P. T. C., 75 ft. from the latter, measured along the center line of track.

From the above the following quantities are computed:

$$I = 8.5944° = 8° 35' 40''$$
$$\phi_1 = 2.1486° = 2° 8' 55''$$
$$x_1 = 74.989 \text{ ft.}$$
$$y_1 = 0.937 \text{ ft.}$$
$$\cos \phi_1 = 0.9993$$
$$\sin \phi_1 = 0.0375$$

1st Trial—The frog point is assumed to be 66 ft. from the switch point. (Being practically the lead on a tangent track for a No. 7 frog, this is a very rough approximation.) This gives:

$l_2 = 141.000$ ft.; $\phi_2 = 7° 35' 38''$; $\cos \phi_2 = 0.9912$; $\sin \phi_2 = 0.1322$; $x_2 = 140.752$ ft.; $y_2 = 6.222$ ft.; $G_2 = 4.686$ ft.; $g_2 = 0.399$ ft.

Using the formulas given for Case III in the table, Fig. 2, we have:

$$A S = 4.686 - 6.222 + 0.937 = -0.599 \text{ ft.}$$
$$A F = 0.399 + 140.752 - 74.989 = 66.162 \text{ ft.}$$
$$\log (-\tan \alpha) = 7.95682$$
$$\alpha = -(31' 7'')$$
$$f_2 = -(1° 2' 14'') + 2° 8' 55'' + 7° 35' 38'' = 8° 42' 19''.$$

The value required for a No. 7 frog being 8° 10' 16", we have

$$\Delta f_2 = -(32' 3'') = -0.5341°.$$

1st Correction:

$$N = -114.6$$
$$\frac{66.162 \times 0.1322 + (-0.599) \times 0.9912}{(66.162)^2 + (0.599)^2} + \frac{2 \times 7.594}{141} = -0.1056.$$
$$\Delta l_2 = \frac{-0.5341}{-0.1056} = 5.058 \text{ ft.}$$

Since Δl_2 is thus shown positive the value first assumed for l_2 should be increased.

2d Trial:

$$l'_2 = 141.000 + 5.058 = 146.058 \text{ ft.}$$
$$\phi'_2 = 8° 8' 55''$$
$$x'_2 = 145.762 \text{ ft.}$$
$$y'_2 = 6.915 \text{ ft.}$$
$$\cos \phi'_2 = 0.9899$$
$$\sin \phi'_2 = 0.1417$$
$$G'_2 = 4.683 \text{ ft.}$$
$$g'_2 = 0.422 \text{ ft.}$$
$$A S' = -1.295 \text{ ft.}$$
$$A F' = 71.195 \text{ ft.}$$
$$\alpha' = -(1° 2' 31'')$$
$$f'_2 = 8° 12' 48''.$$

If the latter value for f_2 is not sufficiently exact it may be further improved through a repetition of the process:

2d Correction:

$$N' = -114.6$$
$$\frac{71.195 \times 0.1417 + (-1.295) \times 0.9899}{(71.195)^2 + (1.295)^2} + \frac{2 \times 8.1486}{146.058} = -0.0875$$
$$\Delta f'_2 = 8° 10' 16'' - (8° 12' 48'') = -(2' 32'') = -0.0422°$$
$$\Delta l'_2 = \frac{-0.0422}{-0.0875} = 0.482 \text{ ft.}$$

3d Trial:

$$l''_2 = 146.058 + 0.482 = 146.540 \text{ ft.}$$
$$\phi''_2 = 8° 12' 9''$$
$$x''_2 = 146.240 \text{ ft.}$$
$$y''_2 = 6.983 \text{ ft.}$$
$$\cos \phi''_2 = 0.9898$$
$$\sin \phi''_2 = 0.1427$$
$$G''_2 = 4.682 \text{ ft.}$$
$$g''_2 = 0.424 \text{ ft.}$$
$$A S'' = -1.364 \text{ ft.}$$
$$A F'' = 71.675 \text{ ft.}$$
$$\alpha'' = -(1° 5' 25'')$$
$$f''_2 = 8° 10' 14''.$$

The last value for f_2 is practically correct, the variation from the required value, 8° 10' 16", being well within the limits of error.

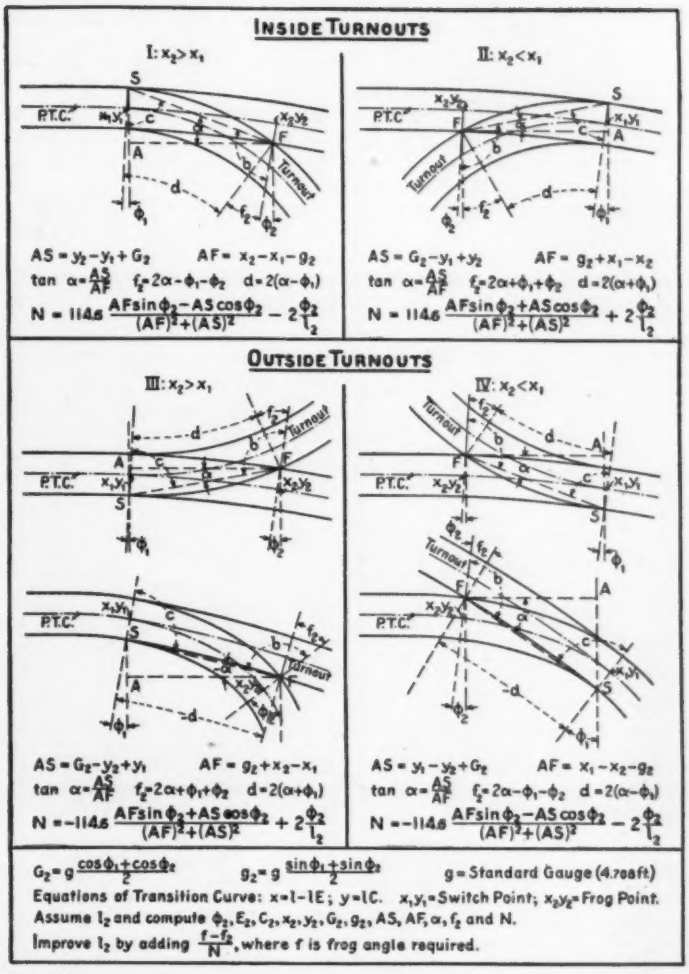

INSIDE TURNOUTS
I: $x_2 > x_1$
II: $x_2 < x_1$
OUTSIDE TURNOUTS
III: $x_2 > x_1$
IV: $x_2 < x_1$
P.T.C.
Turnout
$AS = y_2 - y_1 + G_2$ $AF = x_2 - x_1 - g_2$
$\tan \alpha = \frac{AS}{AF}$ $f_2 = 2\alpha - \phi_1 - \phi_2$ $d = 2(\alpha - \phi_1)$
$N = 114.6 \frac{AF \sin \phi_2 - AS \cos \phi_2}{(AF)^2 + (AS)^2} - 2\frac{\phi_2}{l_2}$
$AS = G_2 - y_1 + y_2$ $AF = g_2 + x_1 - x_2$
$\tan \alpha = \frac{AS}{AF}$ $f_2 = 2\alpha + \phi_1 + \phi_2$ $d = 2(\alpha + \phi_1)$
$N = 114.6 \frac{AF \sin \phi_2 + AS \cos \phi_2}{(AF)^2 + (AS)^2} + 2\frac{\phi_2}{l_2}$
$AS = G_2 - y_2 + y_1$ $AF = g_2 + x_2 - x_1$
$\tan \alpha = \frac{AS}{AF}$ $f_2 = 2\alpha + \phi_1 + \phi_2$ $d = 2(\alpha + \phi_1)$
$N = -114.6 \frac{AF \sin \phi_2 + AS \cos \phi_2}{(AF)^2 + (AS)^2} + 2\frac{\phi_2}{l_2}$
$AS = y_1 - y_2 + G_2$ $AF = x_1 - x_2 - g_2$
$\tan \alpha = \frac{AS}{AF}$ $f_2 = 2\alpha - \phi_1 - \phi_2$ $d = 2(\alpha - \phi_1)$
$N = -114.6 \frac{AF \sin \phi_2 - AS \cos \phi_2}{(AF)^2 + (AS)^2} - 2\frac{\phi_2}{l_2}$
$G_2 = g \frac{\cos \phi_1 + \cos \phi_2}{2}$ $g_2 = g \frac{\sin \phi_1 + \sin \phi_2}{2}$ g = Standard Gauge (4.7 feet)
Equations of Transition Curve: x = l − lE; y = lC. $x_1 y_1$ = Switch Point; $x_2 y_2$ = Frog Point.
Assume l_2 and compute $\phi_2, E_2, C_2, x_2, y_2, G_2, g_2$, AS, AF, α, f_2 and N.
Improve l_2 by adding $\frac{f - f_2}{N}$, where f is frog angle required.

FIG. 2. FORMULAS FOR TURNOUTS FROM CRANDALL'S TRANSITION CURVES

The above example differs from that shown by the upper sketch of Case III, in having point F below (instead of above) point S; this is represented in the negative sign of α. Therefore, the central angle of the turnout, d, is found from the difference between the numerical values of α and ϕ_1, instead of from their sum:

$$\tfrac{1}{2} d = 2° 8' 55'' - 1° 5' 25'' = 1° 3' 30''$$
$$d = 2° 7' 0''.$$

the positive sign of d indicating that the center of the turnout is located on the outside of the transition curve, as shown in the upper diagram of Case III.

An Important Improvement in Screw propellers was described at the recent annual meeting of the German Institution of Naval Architects. It is well known that to secure the greatest efficiency in vessel propulsion, the stream of water delivered by the paddle-wheel, the screw or other device used for driving the vessel should be directed straight back. One important source of loss in the screw propeller is that the water is given a rotary motion by the screw and a considerable part of it is directed tangentially by the centrifugal force. The improvement in screw propellers described by Dr. Wagner before the German Institution consists in placing a series of fixed blades behind the rotating blades of the propeller, which blades are given such a shape as to cause the stream of water from the screw to be directed straight astern. It is true that the friction of the issuing stream of water against these fixed blades operates to retard the vessel and reduce the efficiency of the screw, but this is much more than offset by the gain due to the straightening of the issuing stream. Dr. Wagner claimed that careful tests on a vessel had shown that by means of these fixed blades the efficiency of the screw propeller could be raised some 10 to 15% and the net efficiency of the screw as a means of propulsion could thus be increased to 85 to 87%. The device has been applied to 13 motor boats and other small vessels and to one steam-turbine driven torpedo boat. At very slow speed, the device somewhat reduces the efficiency of the screw, but at cruising speed the efficiency is materially raised, and at the highest speed it is very much increased. It is also claimed that the vibrations of the vessels due to the action of the propeller were reduced and the vessels did not settle at the stern as much. An important advantage was claimed for the device when applied to vessels used in towing on canals. Owing to the straight path of the water leaving the screw, the erosion of the bottom was much decreased.

A Novel Road Machine

By A. B. McDaniel*

During the latter part of October, 1911, the writer was on an automobile reconnaissance of the proposed Meridian Road through South Dakota and the southern part of North Dakota (described in Engineering News, Jan. 25, 1912). While passing through southeastern North Dakota, the remarkable smoothness and excellent construction of the earth roads, were especially noteworthy. Upon inquiry at the town of Fairmount, it was learned that the roads were being maintained with a road machine, which has been recently invented and built by W. K. Stebbins, a local manufacturer.

Fig. 1. A Combined Road Scraper and Roller
(Invented by W. K. Stebbins, Fairmont, N. D.)

A general view of the machine is given in Fig. 1. It will be seen that the machine consists of a frame of plain iron bars, the rear ends of which are bent out and down to accommodate the bearings of a metal roller. This is filled with concrete and above it is a shelf, on which one or more concrete slabs may be placed to furnish extra weight as needed for compacting various soils.

The forward ends of the frame sidebars are bent in the V shape and at their ends hold a socket, for the spindle of the front truck. This last consists of a shaft on which turn two small flanged wheels. The latter serve to guide the machine and prevent lateral slip.

From the central part of the frame is suspended a scraper. The latter is connected by rods to a rock shaft and each end is adjusted vertically by bell-crank hand levers which rotate over a segmental rack with hand piece and catch. The seat for the driver is at the rear of the frame, nearly over the roller. At the front end of the frame, a draft tongue projects and, together with doubletrees and singletrees, forms the attachment for the four horses, which haul the machine.

The blade and roller have an effective width of 7 ft. The machine proper weighs 650 lb.; the roller weighs 750 lb. more; the rear weights complete weigh 800 lb., making a total weight of 2200 lb. Allowing 150 lb. as the weight of the operator, the effective rolling or compacting weight would be practically one ton.

The cost of the machine is about $100 and as all the parts are simple and easily repaired, the cost of maintenance is slight. The cost of crowning a new earth road is about the same with this machine as with an ordinary road grader. The principal field of usefulness for this device is in the maintenance of an ordinary road surface; here it will greatly excel the road grader or the drag in effectiveness and economy.

A typical earth road, near Fairmount, in its usual rough and rutted condition after a fall rain, is shown in Fig. 2. Work was begun on a half-mile length at 8 o'clock one morning. At noon of the same day, the surface of the road had been made smooth and hard.

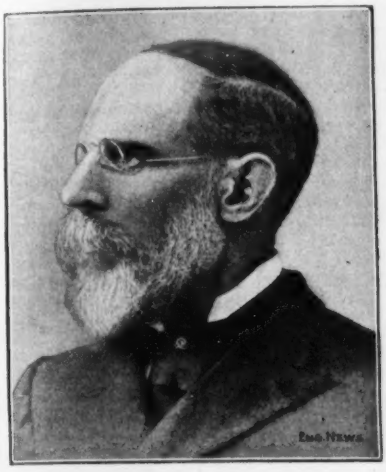
Experience on the fairly level roads of southeastern North Dakota shows that with this machine about three miles of rough road and about five miles in average shape may be put in first-class condition in a 10-hour day. The cost of operation of the machine, including the labor of an operator at 20c. an hour and two two-horse teams at 20c. each per hour, was $6 for one 10-hour day. Assuming that one machine can drag and roll three miles of road surface a day, this would make the cost of maintenance about $2 per mile. It is to be understood that the data given above apply only to earth roads, with the material a sandy loam, the width of the finished road surface 16 ft., and grades very light. For roads of other material and where the finished surface is wider or the grades are steeper, the above data would have to be modified to suit local conditions.

Fig. 2. A Rutted North Dakota Road, Before Working with Stebbins' Machine

*Professor of Civil Engineering, College of Engineering, University of South Dakota, Vermillion, S. D.

John Burkitt Webb

A short biographical sketch of the late Prof. Webb appeared in our issue of last week. In this issue we reproduce a portrait of Prof. Webb, obtained through the courtesy of Prof. F. De R. Furman, of Stevens Institute of Technology.



Besides the various activities of Prof. Webb mentioned in our columns of last week, he was a judge at the International Electrical Exhibition, in Philadelphia, Penn., in 1884, and a member of the jury of awards at the Louisiana Purchase Exposition, in St. Louis, Mo., in 1904.

Notes from Engineering Schools

COLUMBIA UNIVERSITY—In connection with the graduate course in highway engineering, the following illustrated lectures will be given in March. The lectures are public, but the doors of the lecture room (Engineering Building) will be closed five minutes after the lecture begins (scheduled at 8:30 p.m.).

March 4—"Sand-Clay Roads and Oil-Cement-Concrete Pavements," Logan W. Page, Director of the U. S. Office of Public Roads, Washington.

March 8—"Mixing Plants for Bituminous Pavements," Francis P. Smith, Consulting Engineer, New York City.

March 11—"Comparison of Pavements," George W. Tillson, Consulting engineer to the president of the Borough of Brooklyn, New York City.

March 15—"The Construction and Maintenance of Park Roads." John R. Rablin, Massachusetts Metropolitan Park Commission, Boston.

March 25—"The Organization of the State Highway Department of New York." John A. Bensel, State engineer of New York, Albany.

March 27—"Asphaltic Crude Oils and Their Use in Highway Construction," Dr. Albert Sommer, Consulting chemist, Philadelphia, or "The Construction and Maintenance of European Roads," Arthur H. Blanchard, Professor of highway engineering, Columbia University.

A Locomotive Boiler Exploded Mar. 1, at Muncy, Penn., 14 miles south of Williamsport, on the Philadelphia & Reading R.R. Four men in the cab were killed. The accident occurred when the locomotive, attached to a freight train, was running at high speed past the Muncy station. Reports state that one side of the wooden depot was wrecked.

The Pennsylvania R.R.'s 18-hr. train, from New York to Chicago, was derailed, Mar. 4, at Glenville, Ohio, between Bucyrus and Upper Sandusky. None of the passengers or crew was killed or seriously injured. Reports state that only the two locomotives and one coach left the rails. The accident is ascribed to the breaking of a wheel on the second engine's tender.

The Flood Protection Work at Black River Falls, Wis., is now well advanced, and will protect the town from a repetition of the disaster of October, 1911. At that time (as described in our issue of Oct. 19, 1911) a sudden flood in the Black River was checked by a dam, and its force diverted against the unprotected river bank, with the result that a new channel was created and a large section of the business part of the town was washed away. The greater part of the old dam has been removed and a coffer-dam built across the new channel, thus turning the river back into its old bed. Behind the coffer-dam a retaining wall is being constructed, to prevent erosion and to confine the steam permanently to its origimal course. It is proposel to rebuild the dam, using a series of Taintor gates to give greater capacity for flood discharge. As the wall has taken somewhat longer than was anticipated, it was feared that the spring floods would occur before the work could be completed, but it is hoped to have it so far advanced that these floods will do no damage. D. W. Mead, consulting engineer, of Madison, Wis., is in charge of this work for the state of Wisconsin.

New Subways in New York are proposed by the Interborough Rapid Transit Co. in a new offer to the city following after a long period of fruitless negotiation between the city and the company last summer. At that time the Interborough Rapid Transit Co. and the Brooklyn Rapid Transit Co. bid in competition for the construction and operation of new subways, and the city authorities preferred the proposal of the Brooklyn Rapid Transit Co. Recently various interests induced the starting of further negotiations between the city and the Interborough to bring about a new offer to the city on better terms than those which were rejected by it last year. The result is the present proposal, which according to the expressed opinion of the most influential city officials, including the Chairman of the Public Service Committee and a majority of the members of the Board of Estimate, is likely to meet their approval and is therefore likely to be accepted formally. It is asumed that the execution of this plan would not interfere seriously with the acceptance of an operating contract on other subway lines by the Brooklyn Rapid Transit Co. The Lexington Ave. or Triborough subway, most of which is now under construction, would be in part turned over to the Interborough and in part operated by the Brooklyn Rapid Transit Co. The latter's part in connection with the existing Centre St. loop subway (which has never been operated up to the present) and in connection with the Fourth Ave. subway in Brooklyn (now nearly completed and soon to be extended under a project recently formulated by the Public Service Commission) would form an extensive loop system connecting the heart of Manhattan with Brooklyn.

The Interborough proposal of last year involved preferential payment to the company from the gross earnings in an amount which in connection with equalization of the profits from the present subway operated by that company would make a preferential return to the company on its entire system of 9%. The plan now proposed in effect reduces this preferential payment to 8.76%, consisting of a preferential payment of 6% on the cost of the new line and a payment of 2.76% for reduction of lease to 49 years on the whole system and maintenance of the rate of profit of the existing system as shown by the figures of earnings for the last two or three years. After the company has obtained the return of 8.76% the city receives payment up to a total of the same percentage for itself, and thereafter the profits are divided equally. The plan also involves an equalization of franchise period so as to bring the franchise for the new line and the franchise for the existing subway to a termination at the same period, in place of allowing the lease on the present subway to run until 1954 with privilege of 25 years' renewal. Subsidiary features of the proposal are third-tracking of the elevated railways, extension of the elevated system in Bronx borough, and sale of the Steinway or Belmont Tunnel to the city for $3,000,000 (about half its cost) for inclusion in the enlarged subway system.

The proposal is that the city shall contribute $56,000,000 for construction, and the company an equal amount plus $21,000,000 for equipment. The present subway, whose equipment the company values at $48,000,000, is returning 13½% after deduction of rental payments to the city.

The main element of the proposal is a line in Seventh Ave. and Lexington Ave., from the Battery to the Harlem River with extensions in Bronx borough to Jerome, Park and Pelham Bay Park. This would furnish a second complete north-south subway in Manhattan, would serve the Pennsylvania R.R. station, and would give facilities to the upper east side and the lower west side which they now lack. The proposal does not exclude acceptance of a proposal from the Brooklyn Rapid Transit Co., and this latter is expected to be realized for a line through Broadway to 59th St. and thence across the Blackwells Island Bridge, with a tunnel under the East River near the Battery, and operation of the Centre Street loop subway in conjunction with the Brooklyn Fourth Avenue subway with operation of trains across the Brooklyn, Manhattan and Williamsburgh bridges.

The Tunis Monorail Railway, in Pelham Bay Park, New York City, will probably be removed at an early date. A report upon the transit facilities in Pelham Bay Park made by Harry C. Nichols, Chief of the Bureau of Franchises of the Board of Estimate and Apportionment, on Feb. 26, says:

In the Park itself there is but one transit line, the monorail experiment of the Pelham Park R.R. Co. This company never had sufficient capital to give the monorail type of railroad a fair test, but in any event I do not think it adapted to

surface railways, as the high speed it is capable of attaining makes it extremely dangerous at grade crossings. The line as built was not a first-class construction and only one second-hand car was employed.

The permit for operation of the road was revoked by the Board of Estimate on June 22, 1911, but the company has continued the road in operation. It was placed in a Receiver's hands, however, on Dec. 14, 1911. On Jan. 11 the Board ordered the railway removed from the park before Jan. 25. The Receiver of the road, however, has replied that he is without funds to do this work. Mr. Nichols recommended under the circumstances, the city itself should undertake the construction and operation of a standard electric railway in the park, unless some company can be found to undertake the work. Action to this effect was approved by the Board of Estimate at its meeting on Mar. 2.

A Water Tank Wrecked the Factory of the R. J. Ederer Thread Co., at Unity and Elizabeth Sts., Philadelphia, Penn., Dec. 27, 1911, killing two men and injuring eight other persons. The report of a committee appointed by the Bureau of Building Inspection to investigate the accident is now available.

The tank, 16 ft. in diameter and 16 ft. deep, weighing with its contents about 200,000 lb., was mounted on the top of a recently erected brick fire-escape tower which rose 24 ft. above the roof of the building (68 ft. above the basement floor) at the northwest corner. It is claimed by the committee that the faulty construction of the tank supports—for which no permit had been granted nor any drawings submitted to the Bureau—was responsible for the accident.

The tank was supported upon seven 10-in. beams the ends of which rested upon two 12-in. beams about 15½ ft. long. These 12-in. beams were bedded in mortar along the top of the east and west walls of the tower. Each of these walls was 17 in. thick and had a large opening above the roof of the building with a three-ring semicircular arched head. These openings were 9 ft. wide and 11 ft. 6 in. high to the soffit of the arch, which was 9 ft. 6 in. below the top of the wall. The piers at the north side of the opening were 5 ft. wide.

The committee's explanation of the accident is as follows:

> We are of the opinion that the accident was caused by the improper distribution of the weight of the tank and water in it upon the east and west walls. The 12-in. beams were not sufficient to transmit the load directly to the piers at the side of the openings in these walls. As they were bedded in mortar their deflection threw the load upon the arches over the openings. The arches failed and pushed out the north piers and then the falling tank and water carried away the walls below.

A New Cutoff Line of the Chicago & Northwestern Ry. was opened for traffic in December, extending northwest from Milwaukee to Wyeville, Wis. (154 miles), connecting at the latter point with the main line from Chicago to St. Paul. This gives the C. & N. W. Ry. a more direct route between Milwaukee and St. Paul, than had existed before, and also gives an alternative route between Chicago and St. Paul by way of Milwaukee. The new cutoff traverses an agricultural district which has no other good railway communication and will thus develop considerable local traffic. Its main purpose, however, is for through traffic, and for this reason it has been built with low grades and heavy permanent works. A statement issued by the railway company points out that with the completion of this new cutoff there is practically a water-grade line between Lake Michigan ports and Lake Superior ports and the twin cities of St. Paul and Minneapolis. This affords opportunity for the operation of maximum train loads at a minimum of expense.

The physical conditions of the new route are very superior to those of the older route by way of Madison. According to an article in the "Railroad Age-Gazette" the new line saves about 12 miles in distance (between Milwaukee and Wyeville). Its maximum grades are 0.5% against eastbound and 0.7% against westbound traffic; the sharpest curves are 3°, but there are very few curves over 2°. Grades are compensated 0.05% per degree of curvature. On the older route, the maximum grades are 1%, and there is a much larger amount of curvature, besides several tunnels. The new line has one double-track tunnel, 1300 ft. long, in soft sandstone. It is 29 ft. wide between the vertical side walls, and 25½ ft. high above base of rail, the roof arch having a radius of 20 ft. and haunches of 9½ ft. radius. This is lined throughout with concrete. All structures are for double track, and double track (with automatic block signal equipment) has been laid for the first 50 miles.

There are numerous bridges, as in view of the character of the traffic the line was located to avoid highway grade crossings. There are three railway grade crossings. All concrete abutments and substructures are for double track, with double-track truss spans and single-track girder spans. The truss bridges are of the lattice-web type, with multiple intersections.

Two Chicago Commissions have been appointed recently to investigate matters relating to sewage disposal, water power and railway terminals. The mayor has appointed a commission to investigate the problem of simplifying the railway passenger and freight terminals, and to represent the railways on this commission he has appointed S. M. Felton, President of the Chicago Great Western Ry.; F. A. Delano, Receiver of the Wabash R.R., and Charles H. Markham, President of the Illinois Central R.R. The Sanitary District of Chicago has appointed a commission to investigate the possibilities of water power development along the drainage canal and the connecting rivers, and also the utilization of electric current generated at such power plants. In addition, the commission is to consider means of sewage disposal other than dilution, with a view of utilising to better advantage the flow of water in the drainage canal for sewage dilution and disposal. The chairman of the commission is Lyman E. Cooley, consulting engineer; the other members are L. K. Sherman (of L. K. Sherman & Co., engineers and contractors); John Ericson, city engineer; Wm. Artingstall, division engineer of the Board of Supervising Engineers (for Chicago street railways); and H. H. Walker.

Wire-Reinforced Fabric is proposed by Mr. Melvin Vaniman for construction of the gas bag of a transatlantic dirigible balloon. As the result of trials at Atlantic City, N. J., during 1911, with the dirigible "Akron," which it was hoped to navigate from America to Europe, this aeronaut relies on height control and temperature compensation by considerable changes in the pressure of hydrogen in the main bag; a small air ballonet being pumped up or exhausted as the demand for ballast changes. The cloth of the "Akron" bag could be built to stand a gas pressure of only 1.5 in. of water, but reinforcing with steel ("piano") wire, a similar bag is expected to stand 8 in. The wires are to be spaced ⅛ in. apart circumferentially and ⅛ in. longitudinally.

A System of Electric Propulsion will be given trial on the U. S. Naval Collier "Jupiter," which is under construction at the Mare Island Navy Yard in California.

In this system it is proposed to install one turbo-generator running at a maximum speed of about 2000 r.p.m., and delivering current at 2300 volts to induction motors, one on each propeller shaft. The power from the turbine will thus be transmitted to the propeller shafts, electrically, with a speed reduction ratio of 18 to 1. The efficiency of transmission is expected to be about 91%. The water rate for this installation is stated to range from 12.15 lb. per shaft hp. at 14 knots, to 15.55 lb. at 10 knots.

Contract for the machinery has been placed with the General Electric Co.

Reports that a German Battleship now under construction is to be propelled by Diesel oil engines are confirmed by an article in London "Engineering" of Feb. 9. It states that the Maschinenfabrik Augsburg-Nurmberg A-G, of Nuremberg, Germany, have now completed a three-cylinder double-acting Diesel engine of 6000 b.hp., or 2000 hp. per cylinder. This engine has been run on the testing beds for a considerable time, making continuous runs of several days' duration. A duplicate engine of this type is to be built, and the two engines are to be placed in a German battleship to drive the center shaft, while the two wing shafts will be driven by steam turbines. The same works have built a double-acting engine for a merchant vessel of 2000 hp. having three cylinders of 19 in. diameter and 26 in. stroke. The single-acting two-cycle engine has now the preference, however, and engines of this type up to 2400 b.hp. have been built for use in war vessels.

New Developments in Culebra Cut Slides—On the afternoon of Feb. 10, a portion of the bank of Culebra Cut, Panama Canal, below the old French 90-m. level, on the east side of the Cut, opposite the village of Culebra and about 500 yd. north of Gold Hill, broke off, carrying away the 95-ft. berm and partly closing the recently completed drainage ditch in this locality. All tracks in the pioneer cut and to the eastward of it will have to be regraded and rebuilt. The amount of material in motion in this slide is about 250,000 cu.yd., but other cracks have opened to the south and east of the broken mass, on the old French 90-m. level, which apparently indicate that there will be a considerable addition in the near future, possibly as much more. The closing of tracks on the east side of the Cut will lessen the output for some days to come.

The old slide on the north end of the French dump on the west side of the Cut at Culebra has renewed its activity after a quiescence of over two years. It is estimated that 750,000 cu.yd. of material are in motion. The boundary of the moving mass corresponds closely to that of the clay slide which moved into the Canal about two years ago, leaving underneath it stratified rock sloping about

one on ten toward the Canal. This stratified mass has apparently broken off in a mass, 30 or 40 ft. high on the face, and is advancing toward the prism at the rate of 18 to 24 in. a day. The ground has not heaved up in the bottom of the Cut. The material is easily handled.—"Canal Record," Feb. 14, 1912.

Canada's National Trans-Continental railway, according to a statement made in the Canadian Parliament, on Feb. 14, by Hon. Frank Cochrane, minister of railways, will cost, when completed and turned over to the railway company for operation, $187,781,000. This amount includes interest charges of nearly $19,000,000, which have accrued while construction has been in progress. The total cost per mile of road was stated to be $143,000. Progress on the various sections of the road was reported by Mr. Cochrane as follows:

In district A, from Moncton to the New Brunswick boundary, 266 miles, grading had been completed and track laid over practically the whole section. In district B, from the New Brunswick boundary to the Quebec bridge, 462 miles, track had been laid for 445 miles. In district C, from the Quebec bridge to the Ontario boundary, 121 miles, track had been laid for 77 miles. In district D, from the Ontario boundary to 204 miles west of Cochrane, a distance of 276 miles, track had been laid for 239 miles. In district E, running another 154 miles westward, 154 miles had been graded, but no track had been laid. In district F, running from Superior Junction to Winnipeg, 375 miles, the road was in operation.

A New Type of Towboat for Mississippi River traffic has been invented by Alexander McDougall, of Duluth, Minn. Mr. McDougall became well known some 15 years ago as the inventor of the whaleback barge, which was largely used for ore traffic on the Great Lakes until the deepening of the channels made possible the use of larger vessels, and the development of automatic ore shovels for unloading vessels required decks to be made the full width.

Mr. McDougall agrees with most engineers who have studied the problems that the paddle wheel is superior to the screw propeller for use on the Mississippi River. An objection to the stern-wheel boat of large size and great power is the excessive weight of the stern wheel placed far aft, and the weight of the framing necessary in the hull to support this weight and distribute it. Mr. McDougall proposes, therefore, to build a twin boat, consisting of two rectangular hulls placed side by side, connected by overhead deck framing, with the width between the hulls equal to the width of the paddle wheels. He would place one paddle wheel aft and another of the same size forward, thus equally distributing the weight of the wheels and the propelling machinery over the length of the boat. While twin-hull vessels have been tried before and have been found unsatisfactory, these previous trials have generally been on rough water, where the working of the two hulls strained the connecting framing. With the smooth water of the Mississippi River it is not thought that trouble of this sort would be experienced.

The Plague, Cholera and Yellow Fever were discussed at the International Sanitary Conference, held recently at Paris under the authority of the French Government. Forty-two nations were represented at the Congress, including the United States. It was agreed that the plague is spread by vermin and rats, as well as by infection of the skin and respiratory organs. The commission recommended that any person who had been in contact with the plagued person should be subjected to observation not exceeding five days. As to cholera, it is urged that germ carriers, as well as persons in confirmed stages of the disease, should be kept under observation. Stress was also laid upon the importance of securing improved sanitation at seaports. Yellow-fever patients, as agreed at the Washington Conference of 1905, should be isolated and in general a war should be conducted against germ-carrying mosquitoes at all points where yellow fever prevails.

Personals

Mr. William Crosett, Superintendent of Post & McCord, structural contractors, of New York City, has retired, after 35 years' service.

Mr. Frank J. Zerbee, Master Mechanic of the Cleveland, Cincinnati, Chicago & St. Louis Ry. at Bellefontaine, Ohio, has been appointed Superintendent of Safety Appliances of that railway.

Mr. William C. Williams has resigned as an assistant engineer of the Baltimore Sewerage Commission, on the storm-water drainage system, to accept a position on the New York Barge Canal at Rome, N. Y.

Mr. Timothy A. Reardon, a former deputy in the County Recorder's office and a prominent politician, has been appointed Superintendent of Public Buildings of San Francisco, Calif., at a salary of $3000 per annum.

Mr. Barton R. Shoover, formerly Electrical Engineer for the Youngstown, Ohio, district of the Carnegie Steel Co., of Pittsburg, Penn., has been appointed Superintendent of the new Brier Hill Steel Co., Youngstown, Ohio.

Samuel A. Greeley, formerly in charge of the new garbage-disposal plant at Milwaukee, Wis., has been appointed an assistant engineer for the Sanitary District of Chicago, and is assigned to work relative to the sewage-disposal investigations.

Mr. Henry R. Towne M. Am. Soc. M. E., President of the Yale & Towne Manufacturing Co., of New York City, has been elected President of the Merchants' Association of New York City for a fifth term, by a unanimous vote of the Board of Directors.

Mr. Walter H. Allen, M. Am. Soc. C. E., Civil Engineer, U. S. N., for a number of years connected with the Bureau of Yards and Docks, Washington, D. C., has been transferred to the New York Navy Yard at Brooklyn, N. Y., succeeding Mr. A. L. Parsons, who goes to Washington, D. C.

Mr. Clayton W. Pike, M. Am. Inst. E. E., formerly Vice-President and General Manager of the Keller-Pike Co., Electrical Engineers, of Philadelphia, Penn., has been appointed Chief of the Electrical Bureau of the City of Philadelphia, at a salary of $6000 per annum, succeeding Mr. James F. McLaughlin.

Messrs. Charles H. Repath and A. G. McGregor, mechanical engineers formerly associated with the Amalgamated Copper Co., have formed a partnership under the firm name of Repath & McGregor to conduct an engineering business specializing in mechanical and electrical engineering of metallurgical and mining plants.

Mr. George R. Brown, for the past 12 years with the Massachusetts State Highway Commission, and recently Assistant Division Engineer, has resigned to accept a similar position with the California State Highway Department, of which Mr. Austin B. Fletcher, M. Am. Soc. C. E., formerly Secretary of the Massachusetts Highway Commission, is Chief Engineer.

Mr. Irving H. Reynolds, M. Am. Soc. M. E., Vice-President and General Manager of the William Tod Co., of Youngstown, Ohio, has announced that he will soon retire from the management of this company. Mr. Reynolds was for many years with the Edward P. Allis Co., of Milwaukee, Wis., and developed the triple-expansion pumping engines built by that firm.

Messrs. Wm. R. Yount, formerly on the staff of the Chief Engineer of the Cleveland, Cincinnati, Chicago & St. Louis Ry., and L. N. Jackson, until recently Division Engineer of Maintenance-of-Way of the Chesapeake & Ohio Ry., of Indiana, have formed a partnership under the firm name of Yount & Jackson, for the practice of municipal, sanitary, hydraulic and railway engineering, with offices in Dayton, Ohio.

Obituary

Fred W. Doty, President of the Doty Engine Works, of Goderich, Ont., and Winnipeg, Man., died at his home in Goderich on Feb. 26. He was 60 years old.

C. E. Moore, M. Am. Soc. C. E., Consulting Engineer, of Santa Clara, Calif., died on Feb. 27. He was a native of Vermont and 61 years old. He had supervision of the construction of the waterworks for Santa Clara, Mountain View, Calif., and Tonopah, Nev. Previous to settling in California Mr. Moore had been Principal Assistant Engineer of the Fort Street Union Depot Co., of Detroit, Mich. He was elected a member of the American Society of Civil Engineers in 1880.

Frank Stuart Bond, at one time President of the Philadelphia & Reading R.R., and later Vice-President of the Chicago, Milwaukee & St. Paul Ry., died at Jekyll Island, Georgia, on Feb. 26, aged 82 years. He began railway work in the office of the treasurer of the Norwich & Worcester R.R. in Massachusetts. Besides the two offices above mentioned, Mr. Bond was previous to that time Vice-President of the Missouri, Kansas & Texas R.R. and Vice-President of the Texas & Pacific Ry. He retired as Vice-President of the Chicago, Milwaukee & St. Paul Ry. in 1900.

Robert William Steele, Naval Constructor, U. S. N., retired, died Feb. 29, at his home in Spring Lake, N. J., aged 80 years. He was born in Ireland, Apr. 13, 1831, and was brought to the United States in his early youth. In 1861 he was appointed a master shipwright at the Brooklyn, N. Y., Navy Yard. He served here during the strenuous days of the Civil War, and in 1871 was appointed Assistant Naval Constructor and stationed at the Navy Yard in Philadelphia, Penn. Here he superintended the rebuilding of a number of old monitors. Mr. Steele attained the rank of Naval Constructor in 1875 and was Chief of Construction at Washington, D. C.; Boston, Mass., and Pensacola, Fla., Navy Yards from 1877 to 1882. In 1891 he went to San Francisco, Calif., to take charge of the building, at the Union Iron Works, of the "Monterey," the "Olympia" and the famous battleship "Oregon." He was retired in 1893.

Engineering Societies

COMING MEETINGS

NATIONAL BRICK MANUFACTURERS ASSOCIATION.
Mar. 6-9. Annual convention at Chicago, Ill. Secy., T. A. Randall, Indianapolis, Ind.

CANADIAN MINING INSTITUTE.
Mar. 6-8. Annual meeting at Ottawa, Can. Secy., H. Mortimer Lamb, Room 3, Windsor Hotel, Montreal, Can.

NATIONAL ASSOCIATION OF CEMENT USERS.
Mar. 11-16. Annual convention at Kansas City, Mo. Secy., Edward E. Krauss, Harrison Bldg., Philadelphia, Penn.

AMERICAN BOILER MANUFACTURERS ASSOCIATION.
Mar. 12-15. Annual convention at New Orleans, La. Secy., J. D. Farasey, East 37th St. and Erie R.R., Cleveland, Ohio.

AMERICAN RAILWAY ENGINEERING ASSOCIATION.
Mar. 19-21. Annual meeting at Chicago, Ill. Secy., E. H. Fritch, 962 Monadnock Block, Chicago.

AMERICAN SOCIETY FOR TESTING MATERIALS.
Mar. 28-29. Annual meeting at New York City. Secy., Edgar Marburg, University of Pennsylvania, Philadelphia, Penn.

NATIONAL DRAINAGE CONGRESS.
April 10-13. Annual meeting at New Orleans, La. Vice-President, E. T. Perkins, First National Bank Bldg., Chicago.

AMERICAN ELECTROCHEMICAL SOCIETY.
April 18-20. Annual meeting at Boston, Mass. Secy., J. W. Richards, Lehigh University, South Bethlehem, Penn.

AIR BRAKE ASSOCIATION.
May 7-10. Annual convention at Richmond, Va. Secy., F. M. Nellis, 53 State St., Boston, Mass.

International Railway Fuel Association—The list of papers to be presented at the 4th annual convention to be held at the Hotel Sherman, Chicago, Ill., May 22-25, is as follows: "Standard Locomotive Performance Sheets," R. Collett; "The Use of Anthracite for Locomotive Fuel," T. F. Lloyd; "Drafting of Locomotives to Obtain Maximum Fuel Efficiency," H. B. MacFarland; "Proper Method of Firing Locomotives," D. C. Buell; "Inspection of Fuel from the Standpoint of the Producer and Consumer," J. E. Hitt and Glenn Warner. An additional paper, of which the title has not as yet been announced, will be presented by Prof. W. F. M. Goss, of the University of Illinois.

Albany Society of Civil Engineers—At the regular meeting held at Keeler's Hotel, Albany, N. Y., Mar. 1, State Engineer, John A. Bensel, gave an address on "The Position of the Engineer in Public Life." Mr. Bensel spoke in part as follows:

While I am not arguing that there is any particular gain for the individual in taking up his work along lines of publicity, it does seem to me that it is proper to urge every member of the engineering profession to act along the lines which shall develop him as a man of broad characteristics and give the benefit of his special training to the world at large; not for any particular gain which he will make, but still for the benefit of posterity and also for the benefit of the younger men now coming up.

He referred to the legislation compelling the licensing of engineers as follows:

There is at the present time a movement in many states looking to the licensing of engineers' practice. Many have argued that such legislation would tend to increase the compensation which people receive, and, however gratifying such a feeling may be personally I do not think that it is to be considered as among those things which are likely to happen by the mere fact of legislation providing for the right to practice. On the other hand, it would serve, I think, to knit the main body of engineers to better establish their position in an engineering way before the public and add to that term which is oft-times misapplied and which is the necessary part of any professional man's work, namely, that prescribed as Ethics, and slowly but surely have such an influence on us as a whole that while we may be said to have added to our troubles we will also receive some compensation for this addition.

The position at the present time of the engineer may be said to be one in which he is hidden and escapes both the emoluments and the troubles that come to those who occupy a position of more prominence in the public regard, and as long as this meets with the general approval of those who operate in the management of the forces of nature, it would not be of any use to urge for any change. We are partakers, however, as a fact, of the general feeling of unrest and to some extent of dissatisfaction and the only cure that one can see is the assumption of new responsibilities and burdens which inevitably are attached to those who would appear for criticism before the public. Personally, I think this well for the profession as a whole and that we should take it upon ourselves to carry this additional burden standing as nearly together as is possible, endeavoring along all lines to build up the profession and conception of the work and in all activities particularly those in which the public interest is concerned as in all municipal and state work, giving the opportunity for the public to meet with those who have the actual direction of affairs firsthand, and thus learn to grapple with the new social problems which inevitably confront a man in a public position.

South Dakota Society of Engineers and Surveyors—The third annual meeting was held in the Western National Bank Bldg., in Mitchell, S. D., on Friday, Feb. 23. The morning session was opened with an address of welcome by Mayor Hitchcock of Mitchell, who is also President of the South Dakota Board of Education. Mayor Hitchcock urged the need of efficiency in the execution of engineering work, as well as in the design and planning. The retiring president of the Society, F. B. Howe, of Sioux Falls, in delivering his annual address took as his subject "The Growth of the Society." He pointed out ways and methods to be pursued in upbuilding the organization. Mr. J. L. Wagner presented a paper entitled "Benefit Assessments of Railroads," in which he dwelt particularly upon the assessment of railroad property for drainage improvement. Mr. Wagner pointed out that the method of assessment according to the benefit plan is cumbersome and ineffective.

The afternoon session was opened with a paper on "The Highway Bridge," by H. C. Leibee. Mr. Leibee stated that the laws of South Dakota were defective in that they did not secure competitive bidding and, therefore, were not securing for the taxpayers the kind of structures to which they were entitled. Mr. C. A. Woodworth read a paper on "State Legislation Affecting Engineers and Surveyors," which aroused considerable discussion.

The election of officers resulted as follows: President, B. E. Lovejoy, Redfield; Vice-President, J. L. Wagner, Sioux Falls; Secretary and Treasurer, R. B. Easton, Aberdeen; Directors, H. C. Leibee, Yankton, and S. B. Howe, Sioux Falls. In the evening the members were entertained at a banquet at the invitation of Mr. E. K. Mather, of Mitchell, during which informal addresses were given by prominent business men.

American Society of Civil Engineers—The 41st regular meeting of the San Francisco association of members of this society was held Feb. 16, with an attendance of 83 members and guests. President Grunsky presented his inaugural address, urging the necessity of coördinating the various engineering departments of the government in one Department of Public Works. A paper on "Water Power Development Under Government Control" was read by C. C. Merrill, Chief Engineer, U. S. Forest Service. He reviewed briefly the methods of development and control of water power in various countries, giving particular attention to Italy, Switzerland, Ontario and the United States and explained the chief points of similarity and difference, going into considerable detail as to the methods in the United States.

In discussion of Mr. Merrill's paper, J. D. Galloway referred to the progress of hydro-electric development in California through private initiative before governmental restrictions were enforced and declared that this development would have been impossible under conditions now existing. He distinguished between the timber, coal, and oil resources as subject to exhaustion and the water resources as inexhaustible, and declared that the restrictions of the conservationists were an injurious detriment as applied to the latter.

Wm. Ham Hall spoke in support of Mr. Galloway's attitude, stating that the restrictions in America were more onerous than those of Russia. Luther Wagoner spoke briefly of his experience in Arizona as bearing out Mr. Galloway's position.

W. A. Cattell drew an analogy between the present situation as regards water-power development and that of the railroad development of forty years ago, when private enterprise accomplished the wonders of the age, but thought that the time had now come for the government to intervene to prevent monopoly and special privilege, and that although the present laws might be unduly restrictive, the ultimate result would be generally beneficial.

Pacific Association of Consulting Engineers—This association was recently organized at San Francisco with a charter membership of 22.

The objects of the association as given in the Constitution are the maintenance of a high professional standard among its members, the promotion of a code of ethics, the formation of a schedule of charges and the advancement of engineering knowledge. A code of ethics and a schedule of charges have already been prepared by the association and will be reprinted in an early issue of Engineering News. As a result of a resolution adopted at the December, 1911, meeting of the association, a circular letter has been sent out to the judiciary of California, both state and federal, and to the leading attorneys of the state calling attention to the provisions in the code of ethics referring to the retaining of engineers as expert witnesses in cases at law and requesting their coöperation in bringing about the changes desired. The resolution called attention to the present method of procuring expert evidence in cases at law, whereby engineers acting nominally as advisers of the court, are employed as witnesses and compensated by the respective litigants without the advice or coöperation of the court, being thus subject to partisan influence while in the discharge of a non-partisan duty.

The officers of the society are as follows: President, A. L. Adams; Vice-President, C. D. Marx; Secretary-Treasurer, C. Derleth, Jr., University of California, Berkeley, Cal.; Board of Governors, the above named officers together with C. E. Grunsky and J. H. Wallace.